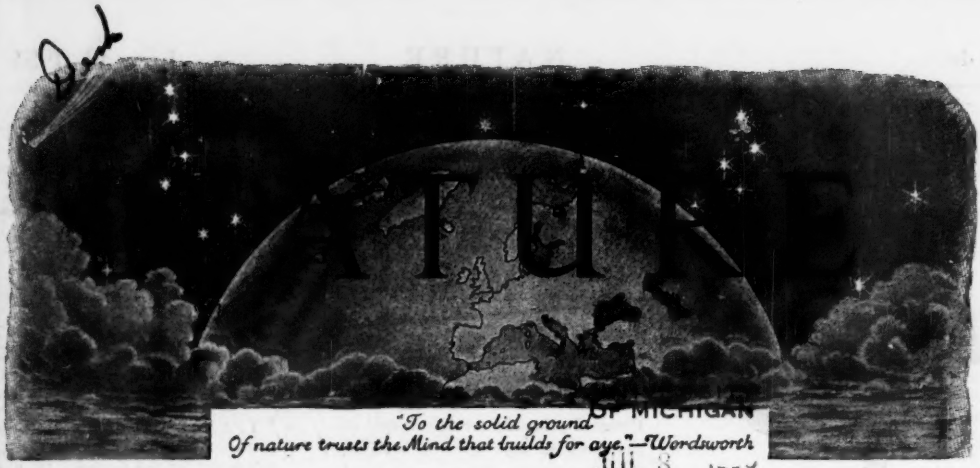

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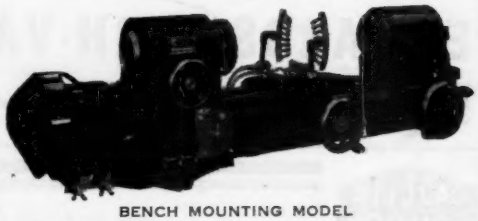

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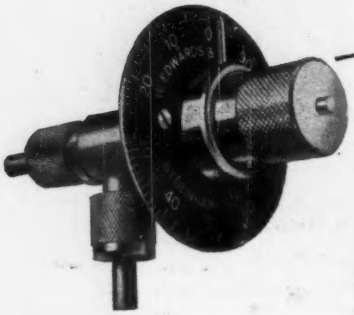

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NATURE

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EDUCATION IN THE MODERN WORLD

VARIOUS reports which during the past two years have dealt with the shortage of science teachers, the expansion of technological education, and the loss of promising students through early school-leaving have increasingly emphasized the dependence of the effectiveness of educational policy in general or of particular measures on public understanding and support. Three years ago, the Advisory Council on Scientific Policy commented on an obstacle deflecting many of the ablest boys from a scientific career—that of the attitude of their parents. The recent report on early school-leaving supplied emphatic evidence of the extent to which the influence of the home could be adverse, and of the frustration and waste that could result if educational policy and institutions were not in harmony with the outlook and aspirations of the home.

References of a similar character are to be found in the report from the Federation of British Industries' Committee on the "Shortage of Science Teachers", in that on "Graduate Teachers of Mathematics and Science" from the National Advisory Council on the Training and Supply of Teachers and, still more recently, from the Committee on the Supply of Teachers of Mathematics and Science in Scotland, appointed in October 1953, with Sir Edward Appleton as chairman*. None of these reports raises the direct question whether the educational system of Britain really fits the society in which we live; but the Appleton report in particular, although by its terms of reference concerned solely with the causes and effects of present and prospective shortages of teachers of mathematics and science in Scottish secondary schools and possible remedies, sees the whole problem against the wider background, and its diagnosis and recommendations have a validity far beyond the Committee's field. The report itself emphasizes the extent to which some of its recommendations will have repercussions outside the sphere with which the Committee was directly concerned.

Some of these repercussions impinge on those coming from the increased awards for university students recently announced by the Minister of Education and from those of the working party on "Grants to Training College Students". It will be noted that both the Minister, in commending the new arrangements to local education authorities, and the working party, in urging the adoption of broadly similar practices by training colleges and standard rates of grant by all local education authorities, appeal for co-operation from local authorities. Without such co-operation, and the public understanding and support upon which it must be based, it will be impossible to eliminate the existing wide variations in grants, and the anomalies and resentment which they engender.

* Scottish Education Department. Supply of Teachers of Mathematics and Science in Scotland: Report of the Committee appointed by the Secretary of State for Scotland. Pp. 40. (Cmd. 9419.) (Edinburgh: H.M. Stationery Office, 1955.) 1s. 6d. net.

More might perhaps have been said in some of these reports of the importance of seeing that the local authorities, for example, and the public which elects them, clearly understand the reasons for the proposed policy, that its purposes are clearly explained and that the real reasons for public expenditure are understood. The report on early school-leaving, indeed, faced this issue frankly in its opening paragraph; but in general more remains to be done to establish clearly in the public mind the real purposes of education, whether it be at the secondary level or at that of the training college, the technological college or the university. With State expenditure on education running at its present level, it is imperative that the public should be assisted to understand clearly exactly what we are trying to do in each type of institution, and equally what we are not trying to do.

As a contribution to public understanding, the Appleton report is outstanding. The critical importance of a single problem is clearly displayed, and its bearing on the national welfare is indicated as well as the implications and repercussions of measures designed to deal with the shortage. No reader of this report is left in doubt as to the folly of attempting to handle educational problems piecemeal or by partisan measures, though there is little that is new in the report itself. It is, above all, in presentation that the report excels.

It begins by emphasizing the gravity of the present shortage of suitably qualified teachers, pointing out that the development of scientific and technological skill upon which the economic prosperity of the nation in peace and its survival in war alike depend cannot be achieved if there is weakness at any level in the educational structure. Although the final stages of the education of those entering the scientific and technological professions are conducted by the universities and colleges of technology, these institutions look to the schools for a student entry which is adequate in both quality and quantity. Any inadequacy in the teaching of mathematics or science at school is therefore a national problem, and if it remains unsolved it endangers our economy and even our safety.

Distinguishing four categories of teachers of mathematics, the report assesses first the nature and magnitude of the problem, and here it supplies fresh information specifically for Scottish schools. Of the first of the four categories—specialist teachers with a first- or second-class honours degree or its equivalent and a specialist course of teacher training normally of one year—there was in October 1954 an actual shortage of 294, and it is estimated that the shortage in 1957 will be about 500. After that year, however, such teachers will be lost by death or retirement at the rate of fifty a year, while on present trends only thirty a year will be recruited. At the same time, the number of pupils in secondary schools will be increasing, as a result of the high post-war birth-rates, from an

estimated 232,000 in 1957 to a peak of about 271,000 in 1961; and it seems likely that while at present the schools require for full efficiency 18 per cent more specialist teachers of mathematics and science, by 1961 they will require at least 40 per cent more. By then the deficiency of specialist teachers will probably be about six hundred.

Shortages of specialist teachers are at present being made good numerically from the second category of teachers of mathematics and science distinguished by the Appleton Committee—sub-specialist teachers with an ordinary (or pass) or with a third-class honours degree. Of nearly 3,000 such graduates employed in Scottish schools at present, almost 2,200 are in secondary schools, and of the remainder it is estimated that not more than 200 would be available for transfer to secondary school work. If these sub-specialists are used to fill the vacant specialist posts, even by calling on the 200 in primary schools and available for transfer, the number of sub-specialist teachers of mathematics and science in the junior secondary schools is likely to fall by at least a hundred during a period when the number of pupils in these schools will rise by 30,000.

This overall shortage of some 700 specialist and sub-specialist teachers by 1961 compares with an accumulated deficiency for grant-aided schools and establishments in England and Wales estimated at 3,450 by 1960 by the National Advisory Council or 2,300 by the Federation of British Industries Committee. The Appleton Committee recognizes that graduate teachers who include mathematics or a science subject in their degree course constitute a small reserve of non-specialist teachers which could be used if the shortage became more acute; but it sees limits to the use which could be made in practice of such teachers. As regards the Committee's fourth category—general teachers for modified courses—it has in mind teachers who undertake with their pupils all the instruction necessary in such cognate groups of subjects as English, history and geography, or arithmetic and elementary science.

Obviously at this point we touch on the extent to which modification of the curriculum could alleviate the shortage. The Appleton Committee firmly rejects the idea of restricting science teaching in schools as a means of saving teaching power; but on a long-term view the way in which science is taught, either in school or university, must powerfully affect the supply and the quality of science graduates and thereby of teachers. Of the quality of science teachers the report says little. The decline in academic standards of those entering the profession is accepted, and the Committee is also fully aware of the danger of deterioration of standards when specialists are replaced by sub-specialists, and the latter by non-specialists. Able pupils, inadequately trained at school in the more advanced work in mathematics and science, may find themselves unprepared for the study of these subjects at the university-level. Other pupils, through faulty introduction, may fail to realize their aptitude for such subjects and turn elsewhere; while apart from this, adverse effects are felt over the whole school curriculum when teachers are withdrawn from work in their own subjects to teach some mathematics or science.

The shortage of teachers of mathematics and science, however, is only one manifestation, although by far the most serious, of the shortage of teachers generally, and of the still more widespread shortage of educated man-power. A fundamental cause of this general shortage of teachers is to be found in changes in the birth-rate; present difficulties in the schools, not only in Scotland but equally in England and Wales, are aggravated by the fact that the schools are dealing with the increasing school population arising from the high post-war birth-rates at the very time when teachers are being recruited from the age-groups born in the 'thirties, when birth-rates were at their minimum. This should indeed be a salutary reminder of the importance of foresight and flexibility in planning educational policy. No adequate policy can be framed and executed if it is subject to party political pressure, and the interests of the nation and the children are made subservient to political doctrine.

The Appleton Committee analyses very clearly other contributory factors which lead it to conclude that the shortage of teachers is but one aspect of an overall shortage of educated man-power. So far as Scotland is concerned, it points out that mathematics and science have not shared in the overall numerical improvement in the staffing of schools between 1939 and 1954, and the present staffing shortage in these subjects will be aggravated when the secondary-school population begins to increase from 1958 onwards. It directs special attention to one particular feature of the shortage of educated man-power which is commonly overlooked. Over the years, the standard of general education required of those entering training for many professions has been raised, while professional courses have been lengthened and final examinations have become more exacting. While this is understandable, it has reduced the proportion of the population upon which the professions can draw.

Rising standards, in fact, conflict directly with the need for more recruits, and the Appleton Committee suggests that we may have reached a condition of unbalance which necessitates reconsideration of requirements for entrance to the universities, the higher technical institutions and the professions. That is highly relevant to the supply of teachers of mathematics and science, because that supply is affected by the demands of industry and commerce to a much greater extent than is the supply of other teachers. The Committee notes, for example, that while the annual output of such specialists from the training colleges averaged 111 during the period 1923–25, 90 in the period 1931–33 and 51 in the period 1936–38, it is now about 40. It does not consider, however, that economic factors are the sole reasons for the preference of young scientists or mathematicians for a career in research in industry or government service rather than in teaching. The passage in which the report discusses the considerations which determine the choice made by young people is one of the most important in the report.

If the bias against teaching is to be corrected, much more positive action will be required than the economic adjustments suggested by the Federation of British Industries Committee's report and others. Those who, like the Appleton Committee, have glimpsed the solid satisfactions which science teaching itself can bring must somehow convince the young scientist and mathematician that the glamour and interest are not all on one side, the drabness and drudgery all on the other. The idea that the teacher deals with his subject on a more or less static level must be dispelled, and the fascination and challenge he meets in problems of presentation and character-building, above all the opportunity and reward of being able to train young minds in the subject nearest to the heart of the teacher, must be displayed in some measure before the budding scientist or mathematician finally decides on his career. Vision indeed is demanded, but besides imagination we touch here on the matter of according the expositor his due honour. Failure to recognize the worth of the expositor may hinder not merely the use and understanding of science but also the very continuance of scientific activity.

This is essentially a matter of long-term policy; but other measures which the Appleton Committee suggest could well be used to improve the position. It does not believe that the problem of obtaining sufficient recruits for the professions will be fully solved by endeavouring to encourage more pupils to stay longer at school. It suggests rather that the professions need to reconsider their standards. Each profession should attract entrants of the highest ability, but many professions could enlarge their lower ranks with persons of less ability than those whom they seek to recruit at present.

Any such policy makes big demands on the professions for searching inquiry and constructive criticism if standards are to be maintained while the public interest is fully served. Moreover, the Appleton Committee considers it essential that an increasing proportion of the population shall be trained as scientists or technologists, and, like the Advisory Council on Scientific Policy and the Federation of British Industries, it suggests that the opportunities in science should be made more widely known both in the schools and to university students who seem to have equal aptitude for a branch of science and for some other study, and find difficulty in deciding in which to specialize. Similarly, it suggests publicity should be given, not only to the advantages of professional careers in general, but also to the very real attractions of a teacher's life.

So much for the general considerations put forward in the report of the Appleton Committee. They make its report of high importance, even apart from the detailed recommendations, some of which may be regarded as short-term measures for the amelioration of the present grave shortage of teachers of mathematics and science. The report as a whole is an outstanding contribution to the present discussion of the form and purpose of education in the world of to-day.

GREEK MATHEMATICS

Science Awakening

By B. L. Van der Waerden. (English translation by Arnold Dresden.) Pp. ii + 306 + 28 plates. (Groningen: P. Noordhoff, Ltd., 1954.) 19 florins; 5 dollars.

SCIENCE has had many meanings; but to the modern layman it means primarily "what goes on in laboratories", and this must be taken as the generally accepted meaning of the word in the absence of any context. Science in this sense began at the Renaissance in the fifteenth and sixteenth centuries. Before this time philosophers had speculated about astronomy, optics, applied mathematics and chemistry; but they had done little more than speculate and had not thought of testing their speculations by controlled experiments. Mathematics is not usually included within the scope of the word science, so that it is necessary to refer, for example, to "a course of study in science and mathematics". The title of the book under review may thus be said to be misleading, for, instead of describing the origins of the modern scientific era, it gives an account of Greek mathematics and its origins.

The book starts with relatively short accounts of Egyptian and Babylonian mathematics and a very useful chapter on early number systems and the origins of the Hindu–Arabic numerals, discussing the invention of the positional system and the introduction of the zero. It is a surprising thought that in Europe the present number system displaced the Roman numerals only about five hundred years ago.

Although the Greeks themselves believed that mathematics originated in Egypt, recent studies by Otto Neugebauer of the cuneiform texts on clay tablets show that the Greek methods are reminiscent of the earlier Babylonian ones, and it was in fact Babylonian mathematics which supplied a basis for the remarkable Greek efflorescence. Prof. B. L. Van der Waerden gives a most illuminating picture of this early mathematics. Photographs of the papyri and cuneiform tablets are reproduced with transcriptions of the texts, so that an idea is given of the original material with which the investigator has to work. He gives copious translated extracts from such texts as the Rhind papyrus, with occasionally a literal translation followed by the modern interpretation. The account of Greek mathematics from 600 B.C. to about A.D. 500 occupies nearly three-quarters of the book and is divided into five chapters. Each of the first four chapters covers approximately a century, and the last describes the decay of Greek mathematics from the time of Apollonius, about 200 B.C.

Prof. Van der Waerden, with his experience of a life-time spent in algebraic studies, is able to penetrate the mode of thought of the pioneer mathematicians and to convey something of it to the reader. He uses his insight to deduce the origin and authorship of some of the books of Euclid's elements. The problems of the duplication of the cube and the squaring of the circle exercised the thoughts of many of the Greek mathematicians whose works are analysed. Some of the author's deductions are based on slender evidence, which is surprising, since he has a word to say on this fault in the preface. For example, he inquires how Eupalinus in 530 B.C. could construct a straight aqueduct a kilometre long through a mountain, digging from both ends at once, and says he must have used the 'dioptra', an instrument described

nearly six centuries later by Heron of Alexandria in A.D. 60.

The book has many commendable features. There are chronological summaries in tabular form of Egyptian, Babylonian and Greek mathematics against the background of general history. There are twenty-eight excellent photographic plates which have been carefully chosen to stimulate interest and to reinforce the arguments of the text; an archæologist, H. G. Beyen, has written useful descriptive notes about them. There is a very good index, and in the preface there is a statement of what is new in the book, so that anybody who wishes to pass over the general outlines of the subject can quickly find the new contributions to knowledge. For those with a knowledge of school mathematics and an interest in mathematical puzzles and problems, it will be a fascinating experience, and not too difficult, to follow the expert guidance of the author through the pre-Christian mathematical works and gain an insight into the mental processes of these early mathematicians. Even the too-frequent misprints and several jarring colloquialisms do not destroy the pleasure to be derived from this well-presented book.

H. R. Calvert

NATURAL AND ARTIFICIAL SNOW

Snow Crystals

Natural and Artificial. By Ukichiro Nakaya. Pp. xii+510. (Cambridge, Mass.: Harvard University Press; London: Oxford University Press, 1954.) 80s. net.

FALLING snow has fascinated observers since early days. Olaus Magnus is believed to have made the first sketches of snow crystals about A.D. 1550. More faithful drawings showing the hexagonal symmetry were made in the seventeenth century; but it was not until the later eighteen hundreds that scientific study of the formation and development of the subject began, culminating in the important work of Hellmann in 1893. In more recent years many contributions to the subject were made, notable among which were those of Bentley and Humphries in 1931. They photographed many thousands of snow crystals and published photomicrographs of more than two thousand of these. Their method, however, was by no means perfect, and it was not until a few years later when Prof. Ukichiro Nakaya devised means of ensuring practically perfect reproduction that the picture of the snow crystal became a true one.

In 1930 Prof. Nakaya joined the Faculty of Science of Hokkaidô University, Sapporo, Japan, as professor of experimental physics. Severe winters on the high ground in the centre of this northerly island stimulated his interest in snow, and two years later he began his investigations on its structure and formation. Very soon he must have devised an efficient method of photomicrography, because the results of his early observations, which he sent to me in 1934, were already far ahead of those of earlier workers, both in technical detail and in artistic merit. Later he improved his lighting technique by using "a little oblique illumination". In this way he succeeded in obtaining "a clear picture of the minute ruggedness of the surface as well as the boundary shape and distinct images of the internal structure of the crystals".

The present book is to a large extent a recapitulation of the many papers produced by Prof. Nakaya and his associates since the thirties, but only going as far as 1946. A concluding chapter deals in summary with some later investigations. The first part deals with 'natural' snow—the many types that were observed, their physical properties, symmetry, mass, rate of fall and electrical charges. Considerable space is devoted to a general classification of snow crystals. There are seven main divisions which are sub-divided into some thirty-two specific types. These are illustrated very clearly by a series of drawings. One is immediately prompted to compare this classification with that of fallen snow recently published on behalf of the Commission on Snow and Ice of the International Association of Hydrology, in the compilation of which Prof. Nakaya helped and which appears as an appendix to his book. This was devised for the layman and, although it is much simpler, the two classifications are in reasonable accord. It would have been a useful addition to the main classification if each of the photomicrographs at the end of the book had its place in the system appended to it.

The second part of the book describes the artificial production of sublimation crystals, both of snow and 'frost' crystals (which in Britain are more usually called 'hoar' crystals). The difference between the two types is that the frost crystals develop on solid objects on, or in contact with, the ground, whereas a snow crystal grows on to a 'nucleus' consisting of "an ion or a dust or aerosol particle" in the free atmosphere. While, therefore, the production of artificial frost crystals (by allowing water vapour to rise on to a cooled surface) presented no great difficulty, the problem of how to make snow crystals was a much more complex one. Ultimately, after much experimentation, it was found that the suspension of a fine rabbit's hair in the cooled section of a simple but very ingenious apparatus provided conditions more nearly approximating to those which cause the sublimation of a minute deposit of ice on to a particle floating in the atmosphere. This early stage of the crystal the author designates as the 'germ'.

By varying the temperatures and the degree of supersaturation, Prof. Nakaya found that he could reproduce at will "almost every sort of snow crystal in the laboratory". By comparing natural snow crystals with those formed artificially under known conditions, he has attempted "to infer to some extent" the structure of the upper atmosphere, tracing the changing conditions in the various layers through which the crystal fell by identifying the various stages of its growth as shown by the photomicrographs. It will be interesting to see whether this can develop in such a way as to be of value for large-scale investigations of the upper air.

A final chapter deals very briefly with work done on falling snow by Prof. Nakaya and a few other investigators since 1946; it includes a section tentatively handling the mechanism of snow crystal formation.

Summarizing, one may call this work a descriptive treatise on the nature of snow as complete and detailed as is possible to-day. It is essentially empirical—there is little or no theory. The work of the crystallographer scarcely enters into it. A criticism that remains to be made is that some of

the terminology is a little confusing. Two examples may be quoted. It has always been accepted that amorphous deposits of ice due to the freezing of water droplets are called rime, whereas crystalline sublimation forms are known as frost (or hoar); yet the author speaks of both crystalline and amorphous forms of both rime and frost. Again, the term 'powder snow' in this book seems to denote something different from the previously accepted meaning of the word as used by snow-craftsmen all over the world. These are insignificant criticisms compared with the general excellence of this work. The portrayals of snow crystals, upwards of 1,550 in number, are of really exquisite beauty and delicacy, and the book has been handsomely produced with assistance from both American and Japanese sources. In giving praise to the author one should not forget his many helpers, whose enthusiasm, one takes leave to suggest, Prof. Nakaya has himself stimulated.

G. SELIGMAN

BIRDS OF THE SOUTH-WEST ASIAN DESERT

Birds of Arabia

By Colonel R. Meinertzhagen. Pp. xiii + 624 + 28 plates. (Edinburgh and London: Oliver and Boyd, Ltd., 1954.) 84*s*. net.

TWO handsome volumes on the birds of Egypt from the same authoritative pen have long stood on the ornithologist's shelves. Now Colonel R. Meinertzhagen has flanked them with the present work on the area immediately to the east; he does not restrict himself to the political boundaries of Arabia, but deals with the whole desert area of south-west Asia. Based as it is on first-hand knowledge of a subject on which there has hitherto been only a scanty and scattered literature, the book will be a standard for many years to come.

The bulk of the book consists of the systematic account of the relevant species and geographical races, for each of which particulars are given. There are also family keys to identification, and sometimes a general discussion of a genus. Many of the forms are illustrated, in colour plates or text figures, and there are maps showing the entire distribution of various species and their component races.

Short notes (listed at p. 72) on a number of general topics are interpolated in the systematic account, and there are four introductory chapters dealing respectively with the physical characteristics of the area, with desert coloration, with distribution and migration, and with systematics and nomenclature. In these general discussions the author is usually provocative, often controversial, but always stimulating. Occasionally he digresses rather far from his main theme to voice some personal opinion.

On the vexed question of desert coloration, Colonel Meinertzhagen agrees that there is much that is not yet known or fully understood. He inclines strongly to the view that the characteristic colour of desert animals has been evolved as a protection against climate rather than against predators; and that, although pattern may often be of cryptic value, shades of colour are the result of environmental influences.

The author's view is that the bulk of the migration which must traverse the area, from western Asia to East Africa, does so by way of the land-bridge at Sinai rather than on a broad front across the main desert. In the almost complete absence of local data, he bases this opinion on his experience of migration elsewhere; but the more direct approach to the question remains as an interesting task for future observers.

There are nine photographic plates illustrating the country, and these enhance the expression of the author's love of the desert which pervades the book. The nineteen colour plates of birds, one by Thorburn, five by Lodge and thirteen by D. M. Henry, are excellent. The printing and general production are of a high order.

LANDSBOROUGH THOMSON

"TEKTOPIA"

Man and Energy

By Prof. A. R. Ubbelohde. Pp. 247 + 13 plates. (London: Hutchinson's Scientific and Technical Publications, 1954.) 18*s*. net.

PROF. A. R. UBBELOHDE writes with the easy confidence of a master of his subject and has given us an agreeable and unusual book, ranging around the subject of man's relation with energy. While there is nothing that will be new to those schooled in thermodynamics, his treatment will attract the layman and give him an introduction to the sciences of energy. The book is in two parts, the first dealing with the growth of the use of power by mankind, and the second with the growth of knowledge on the subject. The first and historical part breaks away from the old story that has been told so often. Prof. Ubbelohde has absorbed and quoted a number of classical authors but rarely cited, and continually presents a new angle on the story of power.

He introduces a conception new to me, one that is presumably his own, namely, that of the Tektopia. "Tektopias are theoretical constructions of ideal states, based on a large proportion of inanimate energy slaves." There would seem to be some doubt as to the merits of the Greek construction Tektopia: presumably it is a portmanteau word compressed from 'technological Utopia', but I think a Greek would suppose it to be a new disease, 'the condition of melting eyes' (cf., eutectic and myopia). Be this as it may, the word gives the opportunity for a discussion of that way of life, unhampered by the embarrassment of having to talk about the habits of particular countries.

The second half of the book is concerned with the foundation and growth of thermodynamics. This is never an easy subject to set before the public at large, but the author has done it as well as it can be done. The cosmic consequences of the laws of thermodynamics are considered—especially with regard to the heat-death of the universe. There is also a chapter on the thermodynamics of living creatures suggesting what seemed to me to be slightly fantastic possibilities of escape of living organisms from thermodynamic laws. The book is illustrated by some good plates and some amusing little diagrams. It is admirably free from misprints, though one of them, "the technological future of madkind", was a stroke of genius by the compositor. This is a book to be recommended to all who seek the wide and human view of science.

F. SHERWOOD TAYLOR

Stainless Iron and Steel

By J. H. G. Monypenny. Vol. 2: Microstructure and Constitution. Third edition, revised. Edited by Prof. F. C. Thompson. Pp. xii+330. (London: Chapman and Hall, Ltd., 1954.) 55*s*. net.

PUBLICATION of the present volume completes the issue of the third edition of this well-known work, and it is a marked reflexion on economic conditions that Vol. 1, issued in 1951, has approximately two hundred pages more than the present volume, which yet costs 10*s*. more. Earlier editions were contained in one volume; but the considerable developments which have since occurred in the subject-matter have made two volumes necessary. Whereas the first deals with industrial and technological aspects, the present one is concerned with more fundamental considerations, namely, with the metallography of stainless and heat-resisting steels.

This work will need no recommendation to those already familiar with earlier editions. However, to others it must be emphasized that here is a well-written and careful account, expressed as simply as possible, which no one concerned with the metallurgy of stainless iron and steel can afford to ignore. Nevertheless, it is necessary to point out that the literature references are not as recent as they might be, presumably due to the unfortunate death of the author before the book was in its final form. Thus there are only four references to work published after 1943, the latest being dated 1949. A. R. Bailey

L'heure H, a-t-elle sonné pour le Monde ?

Effets accumulatifs des explosions nucléaires. Par Charles-Noël Martin. Pp. 255+8 plates. (Paris: Bernard Grasset, 1955.) 540 francs.

THE author, M. C.-N. Martin, is concerned with the global effects of nuclear weapon tests. The main theory dominating the book is that scientists are playing with the unknown and may be exacting a heavy toll from future generations by destroying the delicate balance of Nature. The first half of the book is historical and deals with the development of nuclear technology up to the construction and testing of thermonuclear weapons. The data on the nominal atomic bomb are taken directly from the official United States publication, "The Effects of Atomic Weapons".

The second half of the book discusses the future. M. Martin defines his own position as that of the theoretician who, as distinct from, say, the specialist nuclear physicist, must survey the whole field of physics and consider all the aspects of continued weapon tests which might affect the future of mankind. He admits that it is virtually impossible for a physicist of this generation to do so efficiently, since his knowledge is not adequate; but it is "surely better to make rough estimates and to learn later that they were over-estimates rather than the reverse". This gives him his justification to proceed; but the main weakness of the following chapters is that no estimate in the real sense of the word is made at all. The reader is left to draw his own conclusions from a list of numbers and vague possibilities, with the vital links always missing. Yet much information has been published both in the United States and elsewhere from which realistic estimates could have been made of some of the effects which M. Martin describes in general terms only. Such estimates would have enabled him to consider the potential hazards in their true perspective and to separate the real problems from the imaginary. This procedure might well have been followed for the problems raised by the global deposition of fission products, plutonium, nitric acid and carbon-14 and by the screening of solar radiation by explosion dust, to name a few.

His general arguments are not always consistent. For example, he uses incompatible models of atmospheric diffusion to support his contentions on the hazards associated with dust and with nitric acid. There are several errors of fact in the book, and some of his suggestions are far-fetched, as on p. 169 in which he suggests that nuclear weapon tests may be responsible for the appearance of flying saucers.

N. G. Stewart

Heterocyclic Compounds with Indole and Carbazole Systems

By Ward C. Cumpter and F. M. Miller. (The Chemistry of Heterocyclic Compounds—Vol. 8.) Pp. xii+307. (New York: Interscience Publishers, Inc.; London: Interscience Publishers, Ltd., 1954.) 10 dollars.

THIS is the eighth volume to be published in the Weissberger series of monographs on heterocyclic compounds. It presents a clear and fairly concise account of fundamental indole chemistry embracing indole, indoline and carbazole derivatives, with separate chapters on oxygenated indoles such as oxindole, isatin and indigo. Apart from the systematic survey, the most notable feature—and one not characteristic of the series—is the inclusion of alkaloids as a topic. This occupies almost a third of the book, all the major types of indole alkaloid being represented and briefly discussed from the structural point of view. The authors aim at a comprehensive rather than exhaustive treatment, with literature coverage including the year 1952.

The reader who is familiar with earlier volumes of the series may miss the documented lists of individual compounds, which there supplemented the more general descriptions: on occasion, he may even be a little disconcerted when his search for detail leads from a rather slender index to a single line of text and thence to a massed array of references set at the foot of the appropriate page. Yet the book will be valued as much for its content as its clarity; and, in particular, the section on indole alkaloids, although lagging already behind recent developments, may be commended to all who seek an introduction to this complicated subject.

Badgers' Year

By F. Howard Lancum. Pp. vii+71. (London: Crosby Lockwood and Sons, Ltd., 1954.) 6*s*. 6*d*. net.

THE year's cycle of behaviour in a family of badgers is the theme of Mr. Howard Lancum's new book. It relates his observations at a sett in a Devonshire wood from April 1952 until March 1953, during which time he spent many nights or parts of nights (forty-six to be precise) watching the inhabitants. He stresses and re-stresses what has long been the contention of field naturalists, that the average, normal badger is harmless to man, very occasional cases of poultry-slaying being the work of eccentric individuals that can rightly be termed 'rogues'. The book is illustrated with excellent photographs taken by the author, including many flashlight pictures of the badgers, both old and young. Frances Pitt

A MAN-CARRYING CENTRIFUGE

By Wing Commander F. LATHAM
R.A.F. Institute of Aviation Medicine, Farnborough

DURING the Second World War, the investigation of the physiological effects of centrifugal force encountered during combat manœuvres in high-speed aircraft assumed increasing importance, as the tolerance of the human body to these stresses was more easily exceeded with each generation of fighter aircraft. The scope of the investigation carried out in service aircraft was necessarily limited, and for this reason human centrifuges were constructed in Canada, the United States, and also Germany, during the later stages of the War. On the basis of the knowledge gained in the design and operation of such installations, the main features of the design of a British centrifuge were decided in 1947. The man-carrying centrifuge at the R.A.F. Institute of Aviation Medicine, Farnborough, now forms the latest addition to the Institute's research equipment. Its mechanical performance and associated electro-medical equipment offer great scope for the conduct of much new basic physiological research, and for the development of equipment designed to increase the speed, comfort and efficiency of aircrew.

The centrifuge consists of a horizontal arm 62 ft. 6 in. long mounted on a 12-ton fly-wheel, which can be rotated in a precisely controlled cycle of acceleration and deceleration. The cars carrying the human subjects are mounted on fore-and-aft trunnions at the ends of the arm, so that they can swing out on rotation and maintain the direction of the resultant centrifugal force on a subject (Fig. 1). A vertical d.c. electric motor developing 2,800 h.p. drives the arm and can be controlled either manually or automatically. The normal operating team consists of a controller, observer at the centre of the arm, recorder and subject. All these operators are linked by 'tele-talk' equipment. With automatic control, each run is governed by one of a series of interchangeable cams, each of which has been designed to give a different rate of application of acceleration from rest, with a different maximum g at the peak.

One of the outstanding features of this centrifuge is its ability to speed up and develop the accelerations on the subject extremely rapidly. With maximum performance, it will reach a speed of 54·4 r.p.m. in 9 sec., which results in a peripheral car-speed of 115 m.p.h. (equivalent to a centrifugal force of 30 g). Once the starting load has been overcome, it means that the centrifugal force can be built up at a rate of 8 g/sec., and reduced at a similar rate by regenerative

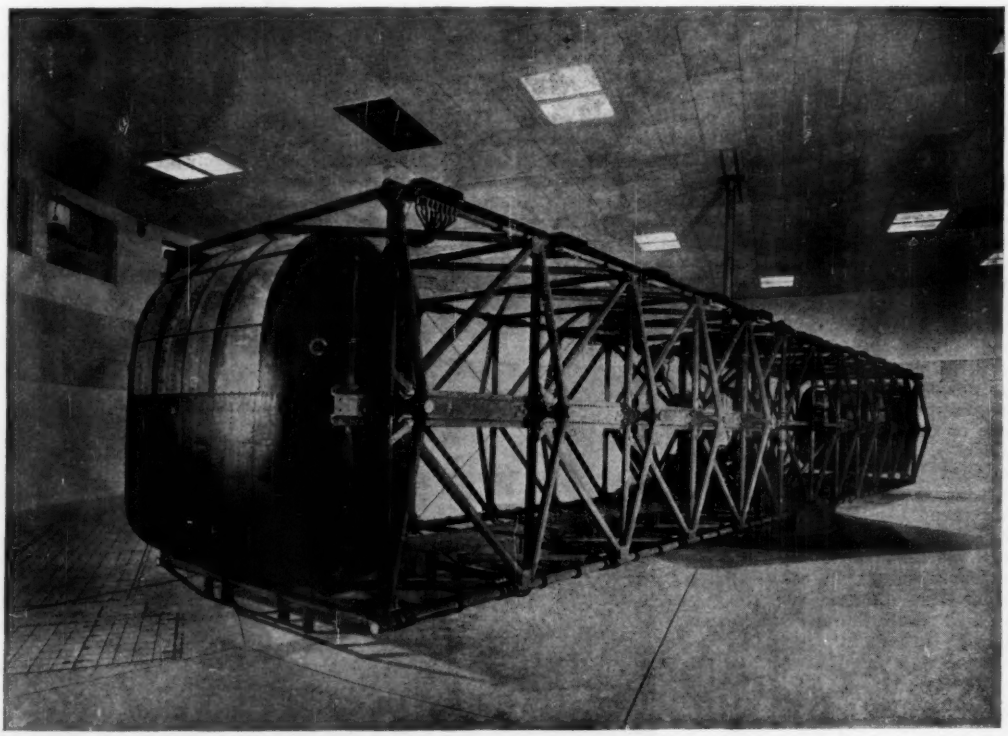

Fig. 1. Man-carrying centrifuge at the R.A.F. Institute of Aviation Medicine, Farnborough. By courtesy of the General Electric Co. Ltd.

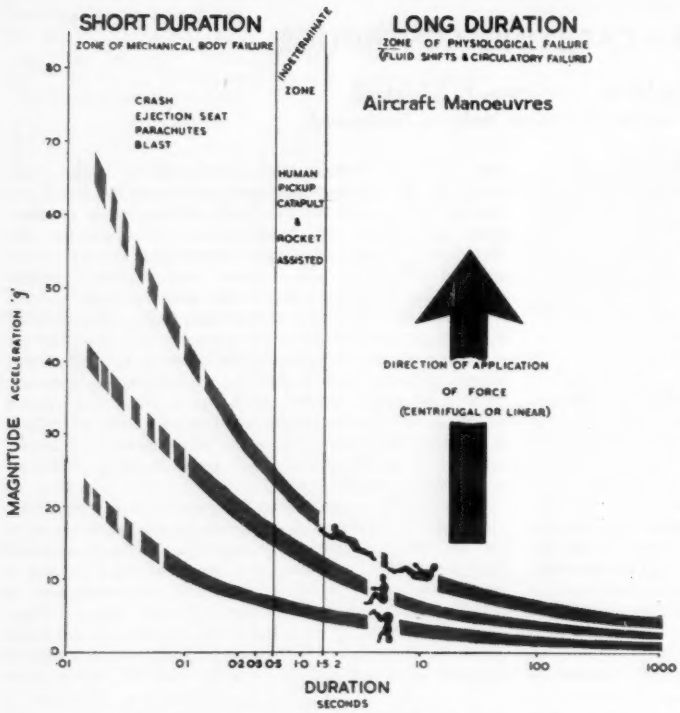

Fig. 2. Anatomical and physiological limits for acceleration in relation to duration and axes of the body

braking at the end of the run. Such a performance compares closely with the rate at which a fighter aircraft can develop *g* forces in combat manœuvres. This feature is important, since time and peak acceleration are the two most critical variables which govern the physiological tolerances of the human body to acceleration stresses. Fig. 2 illustrates this problem and also shows the so-called long-duration group of accelerations which can be investigated with this equipment. Although the centrifuge was constructed primarily for medical research, its size and payload at the end of the arm of 1,150 lb. at 30*g* make it suitable for testing of aircraft and guided missile equipment. For the purpose of studying body movements under *g*, the cars can also be replaced by 'Sorbo'-padded compartments. The limitations of body movement can then be observed while subjects perform simple tasks such as simulating an attempt to leave an aircraft escape hatch under the influence of the increased acceleration experienced during an aircraft spin. The effects of a force of 5*g* on the soft tissues on the face of a subject are shown in Fig. 3.

One of the major problems involved in the design and construction of the building and associated electrical equipment was that of suppression of electrical noise. It is necessary for the electro-medical leads attached to the subject in the car to be conducted along the centrifuge arm and up through the hollow central shaft to the slip-ring room on the top floor of the building, and thence to the recording room. The distance traversed by these cables before reaching the physiological amplifiers is approximately 100 ft., and the sliding contacts which intervene consist of a vertical bank of sixty silver–silver graphite slip-rings, and thirty mercury troughs. Nevertheless, it is possible with the extensive screening and suppression employed to record electroencephalographs from the subjects in the cars while the arm is rotating, with no more than 1½ micro-volts of electrical noise on the amplifiers in the recording room. This recording equipment includes a 12-channel direct ink-writing electroencephalograph and an 18-channel galvanometer and bromide-paper recorder. In addition, there is an 18-channel d.c. amplifier. Thus all types of electro-medical transducers can be used, including strain-gauges and capacitance and inductance manometers for fluid- or air-pressure measurements. These recording facilities have not been confined to the centrifuge building itself, and special screened-cable extensions have been relayed to the surrounding laboratories. Although it has been suggested that a centralized recording system may on occasions prove inconvenient, it has been found that the overall gain in the quality of the recording techniques and the saving of duplication of equipment have justified this system. It is considered

Fig. 3. Left: normal subject. Right: subject at 5*g*

that the screening of the building is the most effective of any centrifuge in the world.

The study of the dynamics of the blood circulation under the stress of accelerations of long duration by the use of the centrifuge should add considerably to basic knowledge in the field of cardio-vascular physiology. It is known that the phenomenon of 'black-out' in aviators during combat manœuvres is directly related to the impairment of the blood circulation to the brain, and an adequate approach to such problems can only be made by the use of such specialized equipment where subjects can be investigated under controlled laboratory conditions. The scope of this work will be enhanced by a ciné X-ray unit, employing the image intensifier system, in the car. The clinical investigation of aircrew who show abnormal reactions in flight during high-speed manœuvres can now be undertaken in safety.

I am indebted to the Director General of Medical Services, R.A.F., for permission to publish this article.

SEMICONDUCTORS: NO MAN'S LAND BETWEEN METALS AND INSULATORS*

By R. W. DOUGLAS

Research Laboratories of The General Electric Co., Ltd., Wembley

THE crystal detector in the early wireless set consisted of a thin wire or a cat's whisker pressed on to a piece of one of the materials now known as semiconductors. The peculiar properties of this class of materials are such that they cannot be considered either as metals or insulators, but as lying somewhere in the no man's land between the two.

A good example of these properties is provided by the electrical conductivity. If a metal wire is used to complete an electric circuit containing a lamp, the lamp will light but will dim slightly as the metal is heated. If the wire is replaced by a bar of a semiconductor, the lamp will not glow until the bar is heated. It is clear, therefore, that a metal conducts electricity far more easily than a semiconductor, although the conductivity of the latter increases with temperature while that of the metal decreases.

To find an explanation for these phenomena, some knowledge of the basic physics of the solid state is required. The modern model of the atom is now well known: a number of electrons revolve in orbits around a central nucleus, each orbit representing a permitted energy-level. This alone does not explain why, when a multitude of such atoms are brought close together to form a solid, the electrons may appear free to wander and to conduct electricity as in a metal, whereas in an insulator such as sulphur no such electrons appear to exist, and in a semiconductor they only appear on heating.

By studying gases, in which the individual atoms are still very far apart, a clear picture is obtained of the behaviour of each atom in isolation. If an electric current is passed through the gas a coloured glow appears, the colour of which is characteristic of each gas. The electric field has provided the outer electrons in the atoms with sufficient energy to jump into more energetic orbits. When they fall back again to their original orbits, they give out a fixed quantity of energy which appears as visible radiation of a particular colour. This is the explanation of the characteristic colours of the argon, neon and helium discharges. A particular mercury vapour discharge lamp can be constructed which emits ultra-violet radiation strongly and, although this is invisible to the eye, it can be detected by a fluorescent screen. If now a small quantity of mercury vapour is inserted between the mercury discharge tube and the screen, this ultra-violet radiation will be completely absorbed again. In other words, the radiation emitted by electrons falling from high- to low-energy orbits has provided exactly the right amount of energy to complete the reverse process in another quantity of the same gas.

In the same way, semiconductors can be shown to absorb radiation. If a series of films of different semiconductors is inserted between a source of radiation, which passes through a prism so as to provide a visible spectrum, each film will cut off a different amount of the spectrum, beginning at the less energetic, that is, the red end. Further, the semiconductor, germanium, will cut off all visible light, but will transmit only infra-red radiation, the presence of which can still be detected by using a thermopile.

For each material the different frequency of light absorbed can be related to an electron jump, just as with mercury vapour. The difference between a solid and a gas, however, is that the solid absorbs all frequencies greater than a certain minimum, whereas the gas absorbs only the frequency corresponding to the energy required to excite an electron from one orbit to another. Instead of fixed orbits in the atomic model of the gas, which can be represented by thin lines, the model for the solid has broad bands of either permitted or forbidden energies which the electrons can or cannot inhabit. This change is due to the fact that, as the atoms are brought closer together to form the solid state, the isolated orbits begin to overlap and to form a series of bands (Fig. 1).

In a metal, one band which arises from occupied orbits overlaps a band which is normally unoccupied. The electrons from the occupied band can then always move up into other energy-levels. When now an electric field is applied, the small additional amount of energy supplied can be absorbed by providing the electrons with more energy.

In semiconductors and insulators, the bands do not overlap, that is, a band occupied by electrons

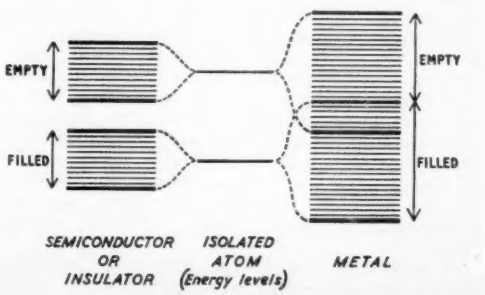

Fig. 1. Energy bands in metals and semiconductors

* Substance of a Friday Evening Discourse at the Royal Institution on May 13.

is separated from an unoccupied one by a region of energies which the electrons are not allowed to possess. If some radiation of sufficient energy falls on one of these materials, it will be absorbed by an electron which can then jump from the full band into the empty, or conduction, band. If the radiation has insufficient energy for this, it passes through without being absorbed. If the forbidden energy gap is not very wide, enough energy for the jump may be provided in the form of heat, which explains why the germanium bar conducts electricity only when heated.

From the width of the forbidden energy gap, it is possible to calculate the number of electrons which will appear in the empty band at any given temperature.

Material	Energy gap	Electrons/c.c. (room temp.)
Metal	—	10^{23}
Germanium (semiconductor)	0·72 eV.	10^{13}
Diamond (insulator)	6·06 eV.	10^{-23}

The decrease in the electric conductivity of a metal with increasing temperature is due to the increased number of collisions between the conducting electrons and the atomic cores. The vibration of the heavy atomic cores increases with temperature, thus increasing the probability of these collisions and so slowing down the conducting process. In a semiconductor, however, the number of conduction electrons increases so rapidly with the temperature that this effect far outweighs any reduction in conductivity caused by these collisions. Another effect also comes into the picture. When an electron is excited from the filled band, it leaves a hole behind. These holes behave exactly like positive charges and thus, for each excited electron, two current carriers are actually produced.

Another way of producing additional current carriers in a semiconductor is by introducing impurities. From the Periodic Table of the elements, it is known that, whereas diamond, silicon and germanium have four outer electrons (the only ones relevant to this discussion), beryllium, aluminium, gallium and indium have three each, and nitrogen, phosphorus, arsenic and antimony have five each. The presence of one atom of arsenic in a bar of germanium therefore introduces a spare electron, which becomes so loosely tied to its parent atom that very little energy is needed to separate it. This can be denoted by putting an extra level in the empty energy band, lying just below the original upper limit of that band. Electrons will, therefore, jump readily from this level into the conduction band. Similarly, the introduction of an atom of, say, gallium, will produce a tendency for that stranger atom to acquire an electron from the surrounding germanium. The extra energy-level will then be just above the upper limit of the original filled band. The energy required to move an electron into this new level is small, so that, even at room temperature, electrons from the filled band can jump into it, leaving behind a positive hole. In both cases, the conductivity of the material has been increased; but, depending on the type of impurity introduced, the semiconductor will show rather different electrical behaviour.

If a wire is connected to germanium containing arsenic impurity (*n*-type semiconductor), with a galvanometer in the circuit, and the wire is heated, the galvanometer deflexion is in the opposite direction

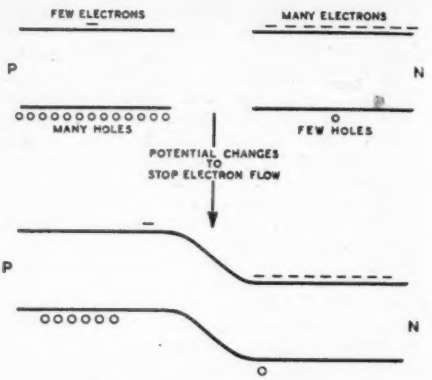

Fig. 2. *p–n* junction; no potential applied

from that obtained using germanium with indium impurity (*p*-type semiconductor). In order to travel from the wire into the *n*-type material, electrons need to absorb energy in the form of heat, so that the junction will cool down. When the wire is heated, therefore, a current will tend to flow in such a direction as to cool the junction. At the junction of the wire in the *p*-type material, on the other hand, there is an evolution of heat as the electrons from the wire give off energy on entering the semiconductor, and a current in the opposite direction will be produced on heating the wire.

If now a junction is made between *n*- and *p*-type materials, electrons will tend to spill from the former to the latter. This produces a change in the potential of the *p*-type material until the number of electrons jumping one way across the junction exactly equals those travelling in the reverse direction (Fig. 2). By connecting a battery across this junction device, different effects are obtained according to the direction in which current is made to flow. In one direction, the flow of electrons across the junction is reinforced, so that very large currents are obtained. In the other, the current will remain constant regardless of the applied voltage. This, of course, means that the device acts as a rectifier, behaving with a very high resistance in one direction and a very low resistance in the other (Fig. 3).

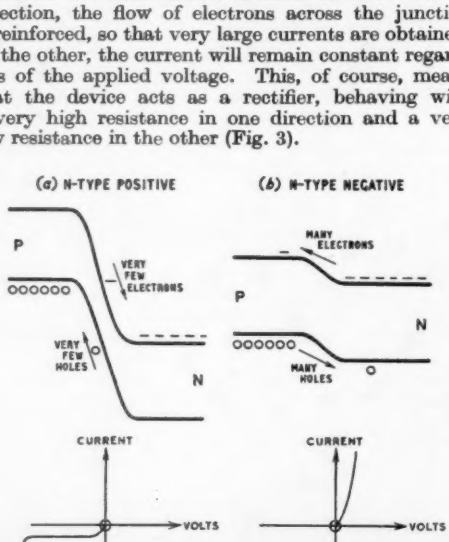

Fig. 3. *p–n* junction; potential applied

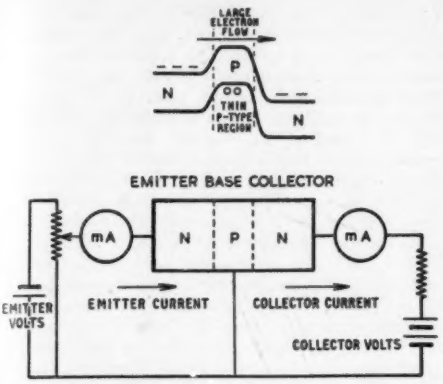

Fig. 4. Crystal triode (n–p–n junction transistor)

Suppose now that a thin piece of p-type material is sandwiched between two pieces of n-type, and two batteries are connected so that one p–n junction has a high resistance and the other a low resistance (Fig. 4). If the p-type semiconductor is thin enough, nearly all the current from the low-resistance junction appears in the high-resistance junction circuit. We can thus produce amplification, since a small change in current in the one part of the circuit can be produced by a small voltage. The same small change of current will appear in the high-resistance circuit and produce a large change in voltage there.

A knowledge of the basic physics of these semiconducting materials has thus led to the development of new circuit devices; the advantages of these crystal rectifiers and amplifiers are already well known, and their applications are increasing daily.

THE MUSEUM OF ENGLISH RURAL LIFE

By J. W. Y. HIGGS
Keeper

AT the end of April the Museum of English Rural Life was opened to the public by Sir Keith Murray, chairman of the University Grants Committee.

The Museum was established by the University of Reading early in 1951 as a national centre for the study of material connected with the history of the countryside. The history of farming and rural life has long been a neglected subject, and the rapid technical advances of the past few years have made it more than ever necessary to save examples of the equipment of the past before it is too late. From the beginning, however, the aim has been to create something much more comprehensive than merely a collection of material—to make in effect a university department which would be actively engaged in research and advisory work, and which as it developed would gather together an invaluable 'library' of information on every aspect of the subject. The Museum represents the first attempt by any university in Great Britain to make a serious study of rural culture, and to form a national reference collection which as it grows should be of immense value to students, to specialists and to other museums. A very high standard in the study of the whole subject of folk culture has been set by the many excellent museums in Scandinavia which have been in existence for many years. It is our hope at Reading that we may be able to follow the general pattern and example of such important institutions as, for example, the Nordiska Museum at Stockholm. It is to be regretted, however, that the work did not begin some twenty years earlier, for much that was of value has already been irretrievably lost.

Up to the present, some four thousand exhibits have been gathered together from all over England; and of necessity during the first four years much time has been devoted to the classification, cataloguing and preserving of these exhibits. The collection is, however, already beginning to be representative, and ranges over many subjects from farming and the rural crafts to domestic life and the social life of the village community. It is not at the present time possible to display to the public more than a selection of the exhibits, though those on view present a fair cross-section and the displays will from time to time be changed. The reserve collections are, however, available for study by specialists and for loan to other museums and institutions. It will also be some time before it is possible to display the many larger items in the collection. This is unfortunate, because many of them are of considerable interest; for example, there is an important collection of four-wheeled wagons. They are rapidly disappearing from the countryside and the art of making them will soon be lost completely; in fact, in the counties of Oxfordshire, Berkshire and Buckinghamshire there is only one man alive who has ever made a wagon. It is hoped that a study of the design and regional variations of these will form the subject of the first handbook to be published by the Museum. There is also a good collection of ploughs, which illustrates clearly the types made by local craftsmen to suit the needs of local soils and conditions. Included in this collection is one of the earliest tractor ploughs, which dates from 1910.

Starting the Museum from nothing has provided a unique opportunity of devising a cataloguing system which, it is hoped, will ensure that an adequate and complete record is compiled for each exhibit. It is all too easy to collect folk material without collecting sufficient background information to explain its proper use and the place it occupied in the system to which it belonged. England is a country of wide variation in farming methods, and the same tool may be used for quite a different purpose in different parts, or conversely quite different tools may be used for exactly the same purpose. The recording system is based on that used in many Scandinavian museums, the main information being recorded on a large index card which incorporates a photograph of the object on the back. It is therefore possible for the student to make a preliminary study of his subject without having to seek at the outset the objects themselves. The process of photographing each individual object has already amply justified the cost, and the fact that the Museum possesses a comprehensive photographic index of its material is already proving useful to other workers in the field. It is intended in time that the catalogue should incorporate material found in other museums in England. Close contact is maintained with museums which have rural collections, and a number have already expressed their desire to participate in such a scheme.

As mentioned earlier, the work of the Museum is by no means limited to the collection of the objects themselves. Every attempt is made to obtain accounts of how processes or operations were carried out. These are sometimes provided by people who themselves remember them, or by the Museum's own staff or collaborators interviewing members of the older generation who can provide useful information. It is intended in the future to expand this work considerably. Already an attempt is being made to photograph sequences of crafts or farm tasks that are becoming rare, and eventually it is hoped to record some of these by making short record-films. It is hoped, too, to prepare questionnaires on certain subjects and to enlist the aid of local historians in compiling them. All these tasks will serve to make the exhibits themselves more useful and to provide a more adequate background to the subject.

The speed with which the Museum has become known is very gratifying. Already it is beginning to be used by many people, and it is clear that the belief of its founders in the need for a specialist museum of this type is amply justified. It is still, however, after four years, at the very beginning of the road; a great deal remains to be done before it can achieve fully the aims which it has set itself. If, however, it continues to receive the enthusiasm and support and assistance which it has met on all sides, its future is assured.

INTERNATIONAL CONFERENCE ON MARINE BIOLOGICAL LABORATORIES

FOLLOWING a decision of the Bureau of the International Union of Biological Sciences, an International Conference on Marine Biological Laboratories was held in Rome during April 18–22, immediately after the meeting of the General Assembly of the International Union. The Committee appointed to take charge of the organization of the Conference consisted of Prof. Robert W. Hiatt (University of Hawaii) as chairman, with Prof. J. Runnström (University of Stockholm) and Prof. C. M. Yonge (University of Glasgow) as members. The Conference was attended by official participants from Canada, Denmark, Egypt, France, Germany, Great Britain, Italy, Japan, Norway, Sweden, the United States and Yugoslavia, while the following additional countries were represented by observers: Austria, Belgium, Finland, India, The Netherlands and Switzerland.

Following an introductory address on the historical development of marine biological laboratories by Prof. C. M. Yonge, the Conference heard accounts by its members of existing marine laboratories throughout the world. Under the leadership of the official participants, discussions then took place covering the whole field of activities of these laboratories. These included the relations of fundamental and applied research with particular reference to fisheries research, the relationship between marine biological laboratories and the physical aspects of oceanographic research and the role of marine laboratories in graduate and postgraduate education. In addition, the relations between marine laboratories and universities and government departments or other institutions was discussed.

Much time was naturally spent dealing with questions of financial support, coming as this may from so many sources, although becoming increasingly dependent on government funds. It was pointed out in later discussions dealing with publication that there are at least a hundred publications devoted wholly or mainly to marine biology (including fisheries), while this number would be more than doubled if journals commonly used for publishing results of marine biological research together with current reports on marine expeditions and surveys were included. The manifold problems of equipment and the technical difficulties of running research aquaria, with the design of research vessels and their gear, occupied much time in the Conference.

Leading naturally from the above topics, which had revealed so much diversity of aim and such varying range of equipment and facilities, the Conference came logically to a consideration of the preparation of an International Directory of Marine Laboratories. No existing directory is in any way comprehensive or covers institutions recently established or which have notably increased their facilities since the Second World War. Finally, at this first preliminary international gathering of marine biologists, the need for some permanent organization was discussed. Not only was this considered necessary, but the need for some central organization from which a bulletin of technical information could be circulated was stressed. At the same time, there was felt to be no reason to increase the number of journals dealing with marine biology but rather to reduce these by fusion of the smaller publications, while the advantage of a laboratory distributing its work in the form of collected reprints was stressed.

Much interest was shown in impending developments, which in Europe include the possibility of the foundation of a marine station at Elsinore, together with much expansion and co-operation of work within the four Scandinavian countries. In Germany the laboratory at Heligoland is to be rebuilt, and it is hoped that the Belgian station at Ostend, destroyed in 1940 and now replaced provisionally, will soon have new buildings. In tropical waters, the activities of the Colonial Fisheries Advisory Committee in establishing laboratories at Freetown, Zanzibar and Singapore were noted with much interest, as were the activities of the University College of the West Indies at Jamaica. The establishment of a second Egyptian marine station near Suez and of laboratories at Curaçao and in Madagascar were reported, together with new Japanese activities in the Bonin Islands. The most obvious gaps in the distribution of marine biological stations appeared to be in parts of the Indian Ocean, notably around Karachi and Ceylon and in the East Indies and also around South America, although there are encouraging activities both in Brazil and in Chile.

After five days of sustained discussion, which all who took part felt fully justified this Conference, the proceedings suitably ended by a visit to the Stazione Zoologica at Naples. There participants and observers were received and entertained by Dr. Reinhard Dohrn and Dr. Peter Dohrn, respectively son and grandson of the founder of this parent institution of all marine laboratories. The great activity of this laboratory, now more than eighty years old, was felt both as a justification of past endeavours and as an encouragement for those of the future.

C. M. Yonge
F. S. Russell

OBITUARIES

Engineer-Captain Edgar C. Smith, O.B.E., R.N.

To readers of *Nature*, the name of Engineer-Captain Edgar C. Smith has been familiar for more than thirty years as that of a scientific biographer and a historian of engineering who combined to an unusual degree a love of precise detail and the ability to present it in arresting perspective with a notable economy of words. In this, however, his writing did no more than reflect his own vivid and forceful personality, and did it so effectively that, even to those who knew him only as a name in print, the news of his death, on March 13, must have brought a sense of individual loss. Those whose good fortune it was to enjoy his friendship are acutely conscious that they have lost something very precious.

No man is indispensable, though every man is in some way unique—a thesis to which Smith was always ready to subscribe; but few historians have laboured to such good purpose as he did in collating and recording the engineering history of the Royal Navy, and assuredly few men forged more numerous ties of real affection in pursuing their researches. His father, a schoolmaster who was living in Newport Pagnell when Edgar Charles was born on May 5, 1872, was keenly interested in science for its own sake, and the school at Gravesend to which he transferred in the following year soon established a reputation for the teaching of elementary natural philosophy. Smith grew up, therefore, in an atmosphere of scientific experiment and inquiry, and was further stimulated by a year spent at Finsbury Technical College under John Perry and Silvanus Thompson—though, as he admitted in later years, he did not feel that stimulus at the time, finding the curriculum rather beyond his power to absorb.

He entered the Navy as a temporary assistant engineer in 1895, having previously acquired a good knowledge of engineering practice in various engineering works, mainly in the West of England, and something of the theory, by attending classes in the Merchant Venturers' College at Bristol. He spent twenty-seven years in the Royal Navy, serving in battleships, cruisers and destroyers, in H.M.S. *Britannia* as an instructor, and in several of the Royal dockyards, retiring in 1922 on reaching the age of fifty. Nearly twenty years earlier he had begun to collect biographical material about eminent scientists and engineers of all nationalities and, on retirement, he set himself to collate it systematically and to fill the gaps that the process revealed. At the same time, he embarked on the prodigious task of establishing personal contact with the whole of the retired engineer officers of the Royal Navy, obtaining their personal reminiscences, and checking the details by direct references to Admiralty records, many of which were wholly unexplored by historians. By this means he was able, after several years of laborious work, to build up a fairly complete picture of the origins and growth of the Engineering Branch of the Royal Navy and to present it in a valuable series of papers to the Newcomen Society (of which he was president in 1937–38), in various articles in the technical and scientific press, and in his book, "A Short History of Naval and Marine Engineering", published in 1938.

Concurrently, he was maintaining a steady flow of contributions to *Nature*, including an annual article on scientific centenaries and other anniversaries, which culminated in a series of articles on "Britain's Scientific Shrines", published in Festival of Britain Year (1951). It was not his last contribution; but it was the most important connected series that he compiled in the biographical field, and stands as a monument to his remarkable industry in collating data and verifying facts. More recently, increasing infirmity prevented him from undertaking anything in the nature of field-work or other physical exertion; but his mind remained as vigorous and his letters as crisp as ever, and his contributions to the deliberations of the Newcomen Society's Council, of which he had been a member since the Society was formed in 1920, were frequent and invariably to the point. Others, no doubt, will continue the historical work that he began; but, so far as the Engineering Branch of the Royal Navy is concerned, it is improbable that they will be able to add materially to the foundation that he laid.

J. Foster Petree

Prof. D. Y. Solandt

The death occurred on March 30, at the age of forty-eight, of Donald Young Solandt, professor and head of the Department of Physiological Hygiene and professor of physiology in the University of Toronto.

Dr. Solandt was born in Ottawa, Canada, the elder son of Mrs. Solandt and the late Rev. Donald McKillop Solandt. Following his secondary schooling, he entered the University of Toronto, with which he was associated, first as a student and then as a member of the staff, until the time of his death. After graduating in medicine in 1933, Dr. Solandt carried on outstanding postgraduate work in the University of Pennsylvania under the direction of Dr. D. W. Bronk. Later he continued his graduate work in Britain in Prof. A. V. Hill's laboratory at University College, London, and obtained his Ph.D. degree from the University of London in 1936. In 1944 he received his diploma of public health from the University of Toronto.

During the Second World War, Dr. Solandt served for three years in the Naval Medical Research Division of the Royal Canadian Navy. His outstanding work, particularly in connexion with protection of night vision, was acknowledged by the award of the Medal of Freedom with Bronze Palm by the Government of the United States. Dr. Solandt's rank was that of surgeon commander.

Dr. Solandt was an outstanding authority on the physiology of muscle and made many significant contributions in diverse fields of research. He was mainly interested, in recent years, in the field of biophysics as applied to physiology and public health. His publications were numerous and appeared in medical and biophysical journals in Britain, Canada, the United States and elsewhere.

Dr. Solandt was a valued member of many committees of the National Research Council of Canada. He also served on the Advisory Committee of the Department of National Health of Canada and the American Public Health Association. He was an honorary Fellow of the American Medical Association, a Fellow of the Royal Society of Canada, and a member of many other scientific bodies.

Dr. Solandt was an exceptionally talented and versatile person. His reading covered a very wide field, and his fund of knowledge outside the realms of science never ceased to amaze his colleagues. His

vigorous intellect and personality and his loyal friendship will always be remembered.

In 1936 Dr. Solandt married Barbara Garrard, a science graduate of Cambridge whom he met while working in London. He is survived by his widow and three daughters, Barbara, Sandra and Diana.

Charles H. Best

Mr. C. H. Dinham

Charles Hawker Dinham, whose death occurred suddenly on February 15, had been a member of the scientific staff of the Geological Survey of Great Britain for the exceptionally long period of forty-three years. Before starting his Survey career in the Edinburgh office of the Survey in 1910 he had distinguished himself at Haileybury as a classical scholar, and became head of the school. Afterwards he was an Exhibitioner at Magdalen, Oxford, where he studied both classics and science.

He gained much experience of Carboniferous geology in Scotland, and also served in Sutherland for a time. A short spell of field-work in Northumberland resulted from his temporary transfer to Newcastle upon Tyne after the First World War; but he returned to Scotland again on promotion to the rank of district geologist, in 1922. In 1927 he was again moved to England, this time to the old Survey headquarters in Jermyn Street, London. Here he took charge of a unit working in the Midlands and Eastern England. This post he held until his sixty-second year, when he retired, but was re-engaged in a lower rank, that of principal geologist, for special geological duties. This was possible under the scheme now operating within the Civil Service by which the services of experienced officers can be retained after they reach the normal retiring age. Dinham continued to serve until, at the age of seventy, final retirement from the Geological Survey became inevitable. Even so, his abiding interest in geology impelled him to carry on, even after he had more than earned the right to complete leisure; and he continued to attend the Geological Survey offices fairly regularly until his death this year. He was, in fact, on his way to South Kensington when the end came.

Dinham lived a life of selfless devotion to the Geological Survey. He made no outstanding contributions to geological science; but it is men such as Dinham, carrying out the day-to-day work of the Survey without thought of personal advancement, who enable it to fulfil its duties to the public. Dinham combined with a very wide knowledge of British geology and exceptionally long experience of Survey work, a pleasant, if retiring, personality. He was very well liked by his colleagues, who knew that they could always turn to him for advice and help which would be freely given. He is survived by his widow and three children.

NEWS and VIEWS

Queen's Birthday Honours

The following names of scientists and others associated with scientific work appear in the Queen's Birthday Honours List:

Baronet: Sir George Nelson, chairman and managing director, English Electric Co., Ltd.

K.B.E.: Dr. Alexander Fleck, chairman of Imperial Chemical Industries, Ltd., for services to the Ministry of Fuel and Power; Arthur H. Gosling, director-general, Forestry Commission; Sir Harold Spencer Jones, Astronomer-Royal; Major-General Jack E. S. Stevens, chairman of the Australian Atomic Energy Commission.

Knights: Harold Bishop, director of technical services, British Broadcasting Corporation; Dr. B. Ifor Evans, provost of University College, London; Edward H. B. Lefroy, for services to agricultural and pastoral industries in Australia; Sangarapillai Pararajasingam, for services to agriculture in Ceylon; John P. Tivey, for services to engineering, science and industry in Australia; Hugh E. Watts, lately H.M. chief inspector of explosives, Home Office.

C.B.: J. N. Ritchie, chief veterinary officer, Ministry of Agriculture, Fisheries and Food; Dr. N. C. Wright, chief scientific adviser, Ministry of Agriculture, Fisheries and Food.

C.M.G.: J. R. Dridan, engineer-in-chief, Engineering and Water Supply Department, South Australia; W. A. Gunn, for services to the pastoral industries in Australia; R. W. Kettlewell, director of agriculture, Nyasaland; H. A. W. Morrice, irrigation adviser and director of irrigation, Sudan Government.

C.B.E.: Dr. A. B. D. Cassie, director of research, Wool Industries Research Association; A. E. Childs, director of chemical defence research and development, Ministry of Supply; K. A. C. Creswell, for services to the study of Muslim architecture and archæology; Dr. J. V. Dunworth, head of the Reactor Physics Division, Atomic Energy Research Establishment, Harwell; A. R. Entrican, director of forestry, New Zealand; W. Fairely, chief civil engineer, Office of the Crown Agents for Oversea Governments and Administrations; G. E. Foxwell, consulting fuel technologist; G. Gibson, chief mechanical engineer, East African Railways and Harbours; Dr. R. T. B. Green, senior bacteriologist, Institute for Medical Research, Federation of Malaya; R. A. Hammond, director of veterinary services, Kenya; Dr. W. C. Moore, director of the Plant Pathology Laboratory, Ministry of Agriculture, Fisheries and Food; Dr. F. G. Morgan, director of the Commonwealth Serum Laboratories, Australia; Dr. D. D. Pratt, director of the Chemical Research Laboratory, Department of Scientific and Industrial Research; Prof. H. G. Robinson, emeritus professor of agriculture, University of Nottingham; Prof. M. L. Rosenheim, professor of medicine, University of London; Prof. J. L. Thomson, professor of mechanical engineering, Royal Military College of Science, Shrivenham; P. B. Walker, deputy chief scientific officer, Royal Aircraft Establishment; J. L. Wilson, for services to the pastoral and agricultural industries in Australia; Miss E. L. Younghusband, lecturer in social science, London School of Economics, chairman of the West London Juvenile Court.

Public Health and Social Medicine at Edinburgh: Prof. F. A. E. Crew

Prof. F. A. E. Crew, who is retiring at the end of this session from the chair of public health and social medicine in the University of Edinburgh, has played

a very notable part in the development of British biology during the past three or four decades. The period about the end of the First World War witnessed an almost revolutionary change in biological outlook—a broadening of interest from the purely morphological to embrace also the physiological, developmental and genetical fields which are now commonly known as 'experimental biology'. Crew, who had served during 1914–18 in India and France, returned to an assistantship in the Department of Natural History, Edinburgh, and threw himself with great vigour into this movement. He was the first editor of the *Journal of Experimental Biology*—now one of the most flourishing biological journals. He also played a considerable part in founding the Society for Experimental Biology, which will celebrate its hundredth meeting this summer at Cambridge.

Crew's own work was in genetics, which was at that time even more of a 'Cinderella' among the biological sciences than it is to-day. Crew's enthusiasm and gift for organization brought into being first a relatively modest sub-department, but after some years this grew into a large Institute of Animal Genetics attached to the University of Edinburgh. During the 'thirties, under Crew's guidance, this was not only undoubtedly the leading department of genetics in the zoological field, but also fulfilled the functions of a national institute of research in animal breeding. A fitting tribute to the value of his work was made when Crew was elected president of the Seventh International Congress of Genetics, held in Edinburgh in 1939. Alas, war broke out while the conference was actually in session, and the meetings had to be abandoned. Crew's steadiness and qualities of leadership in this most difficult situation made a great impression on the international gathering, which few of those who were present have forgotten.

During the Second World War, Prof. Crew served as director of medical research, War Office, and rose to the rank of brigadier. At the close of hostilities he found energy enough to open for himself a new civilian career, returning to Edinburgh this time as professor of social medicine and public health. As after the First World War, he again found himself taking part in the first phases of the development of a new movement of scientific thought, and once again he has left a lasting memorial in the form of a vigorous and flourishing department.

Dr. J. H. F. Brotherston

Dr. J. H. F. Brotherston, reader in public health in the University of London, has been appointed to succeed Prof. Crew. A graduate in arts and medicine of Edinburgh, Dr. Brotherston served during the Second World War as a medical officer in Iraq, Egypt and Sicily. He was wounded in action in 1943, but rejoined the forces in Belgium and Germany, reaching the rank of major. After the War, Dr. Brotherston took the diploma in public health of the University of London, gaining the first place in a large post-war class at the School of Hygiene and Tropical Medicine. He won a Rockefeller fellowship to the United States, where he made a valuable study of training methods in the schools of public health. This was accepted as a thesis for the Dr.P.H. of Johns Hopkins University. Since returning to Britain Dr. Brotherston has held appointments at Guy's Hospital and the London School of Hygiene. During the past five years, Dr. Brotherston has been director of a field-research study area in south-west Hertfordshire. The large research project which he undertook was financed mainly by the Rockefeller Foundation and included investigations of the medical care of the elderly, both in hospital and in their own homes under the family doctor. Studies have been made under his direction of the incidence of health-needs in a sample of families with the object of discovering how these problems are dealt with in a new housing estate. The team of workers has also carried out reviews of the work of general practitioners, maternity and child-welfare services, school health and hospital services for groups of families. The work is intended to show the degree of co-operation between the services. Dr. Brotherston has published books and articles dealing with both historical subjects and with a wide range of problems of medical education. In his new appointment in Edinburgh he will have unusual opportunities for teaching and research in both the postgraduate and the undergraduate fields, and for co-operation with the social science departments within the University and the public health services of the city.

East African Agriculture and Forestry Research Organization : Dr. E. W. Russell

Dr. E. Walter Russell, who has been appointed to succeed Sir Bernard Keen as director of the East African Agriculture and Forestry Research Organization, is at present reader in soil science in the University of Oxford, to which post he was appointed in 1948. After reading mathematics and physics at Cambridge, he became interested in soil science and spent a year with Prof. G. Wigner, of the Technical High School, Zurich, and some time with Prof. B. Polyner, of the University of Leningrad. He joined the staff of the Physics Department of Rothamsted Experimental Station in 1930 and at first his work was principally concerned with problems relating to soil structure and included studies of the absorption of liquids by clays and the mechanism of crumb formation. Arising from some of these investigations a year was spent with Prof. W. A. Patrick, of Johns Hopkins University, Baltimore, as a Rockefeller Fellow. Following on the investigations begun by Sir Bernard Keen at Rothamsted, he has been engaged for the past ten years in an extensive series of experiments on the effects of subsoiling and deep ploughing on crop production in Britain.

Since going to Oxford, his main field of research has centred around the reactions of soil organic matter with clay and soil particles and the behaviour of phosphates in soils. In collaboration with Dr. Scott Russell, who is in charge of the tracer laboratory of the Department of Agriculture, isotopic techniques have been employed in a preliminary analysis of some of the factors which limit the uptake of mineral nutrients from different soil types. Dr. Russell is a member of the Governing Body of the National Institute of Agricultural Engineering, a vice-president of the Institution of British Agricultural Engineers, secretary of the British Society of Soil Science since its formation in 1947 and president of Commission IV (Soil Fertility) of the International Society of Soil Science.

Technological Applications of Irradiation

The United Kingdom Atomic Energy Authority has announced the formation of a Technological Irradiation Group at the Atomic Energy Research Establishment, Harwell. This Group will be equipped

with the largest sources of fission products in Europe and will have by the end of this year a 5,000-curie cobalt and a 5,000-curie cæsium source. By the middle of next year these sources will be doubled, and mega-curie sources for irradiations will be available from fuel elements from a new reactor. It is planned to use for irradiations, machines such as linear accelerators to complement the irradiation programme. This new Group will investigate all possible uses for the millions of curies of fission products which will be available within a short time from British reactors. Already a number of promising applications are being investigated, such as the physical changes due to irradiation of a number of substances and especially those of plastics. Of great interest also is the sterilization of drugs and the possible extension of shelf-life due to radiation. Quite a number of chemical changes which are initiated by irradiation are being investigated already. This new Group will work closely with industrial concerns, and special arrangements are being made so that industry should profit to the fullest extent from this co-operation.

Professional Civil Servants

In his speech at the opening of the tenth annual delegate Conference of the Institution of Professional Civil Servants on May 23, the general secretary, Mr. Stanley Mayne, quoted a recent statement by Dr. (now Sir) A. Fleck that in Britain we have only 64,000 scientists instead of the 90,000 we need. Mr. Mayne said that, in spite of repeated authoritative statements since the Barlow report on scientific man-power, made by the Advisory Council on Scientific Policy and others, there is no indication in the programme of either of the major political parties that it is realized that the supply of scientists and technologists is a major factor in national survival. Mr. Mayne referred also to the establishment in 1945 of the National Agricultural Advisory Service to ensure that the results of scientific research are brought immediately and directly before the industry by skilled interpreters, and he contrasted the prospects offered to the honours graduate entering on such a career with those open to the honours graduate in arts entering the administrative class of the Civil Service. He thinks that the Royal Commission on the Service should ensure that it is no less worth while taking up a scientific, professional or technical career in the Civil Service than it is to take up another type of career. It is also essential to make science teaching an attractive career, as well as to increase the number of science teachers, while facilities for more science students are required both in the schools and the universities. Although something has been attempted in regard to science teachers, Mr. Mayne suggested it was too little and too late; nor does he agree with the University Grants Committee that no further substantial increase in the number of university students can be expected in the immediate future without reducing university standards. We need a sharp improvement in educational facilities, he said, for the present extraordinary variation in educational opportunity in different parts of Britain represents lost opportunities of equipping the young people who, in a few years, will be running industries and conducting research. He thought that the Institution has a great responsibility for stimulating the more consistent and comprehensive thinking which is required about the minimum necessities for the economic survival, let alone the progress, of Britain.

Cancer Chemotherapy National Committee in the United States

In the belief that the state of knowledge of chemotherapy has advanced sufficiently to warrant a national voluntary co-operative programme of research and development for the treatment of cancer by drugs, a Cancer Chemotherapy National Committee has been formed in the United States, headed by Dr. Sidney Farber, scientific director of the Children's Cancer Research Foundation in Boston, with Dr. Kenneth M. Endicott, of the National Cancer Institute, Bethesda, Maryland, as the executive secretary. The sponsoring organizations are the American Cancer Society, the U.S. Atomic Energy Commission, the Damon Runyon Memorial Fund for Cancer Research, the Food and Drug Administration, the National Cancer Institute of the U.S. Department of Health, Education and Welfare, and the Veterans Administration. Representatives of these organizations met recently at the National Institutes of Health, Bethesda, to form the National Committee, and they also appointed an advisory group of six for liaison with the pharmaceutical and chemical industries. In addition, four technical advisory panels have been established and are meeting to assess the progress in cancer chemotherapy research and make recommendations for the future. These panels will cover the fields of chemistry, pharmacology, screening of chemical compounds through experiments on animals, and clinical studies. The sponsoring agencies are providing a small full-time staff, headed by Dr. Endicott, to administer the programme, organize an information exchange and give needed assistance to research scientists. The Committee, which including Dr. Farber consists of ten, will define the scope of the programme, develop general policies, assist in obtaining financial support for the work, co-ordinate the activities of the sponsoring organizations, and observe the rate of progress of the entire effort.

The Coffee Pot: a New Club in London for Young Professional Workers

Many young men and women commencing professional jobs far from the towns in which their parents live find it difficult to meet others who share their interests. To meet the needs of such people, a new club has been opened in London—The Coffee Pot—directed by a committee composed largely of recent graduates and three or four senior members. The club is intended for younger members of the professions, particularly those who are not natives of London. Membership is open to men and women between the ages of nineteen and thirty. The subscription is £2 a year, and there is no entrance fee. There is an 'at home' at the Coffee Pot Club every Monday during 7.30–10 p.m., and there are restaurant and club lounge facilities on Mondays, Tuesdays, Thursdays and Fridays. It is hoped to open other such clubs in various towns, and there are schemes for a London Coffee Pot which will be open every day. Further information can be obtained from the Secretary, The Coffee Pot, 83 Chiltern St., London, W.1.

Origin of the *n*-Sound in Speech

In his paper "Some Remarks on the Origin of the *n*-Sound" (Reykjavík, 1954), Prof. Alexander Jóhannesson, of the University of Iceland, expands, with special reference to the *n*-sound, the theory which, in these pages and elsewhere (see *Nature*, 166,

60: 1950), he and Sir Richard Paget have put forward as to the gestural origin of language. He draws evidence from six unrelated languages or language-groups (Indo-European, Hebrew, Turkish, Polynesian, Greenlandic and Chinese) in an attempt to show the element of meaning common to many words containing the *n*-sound drawn from these diverse sources. His evidence is selected (as in such an investigation perhaps it must be), and he considers his material under three headings: emotional sounds, nature sounds (that is, onomatopœic sounds), and gestural sounds ("imitations of the shape or form of things in surrounding nature and of movement"). Not all linguists would agree with him, however, that these three kinds of sound represent successive stages in the development of human speech; or that the third kind, if it exists, can be recovered sufficiently to help in an understanding of the ultimate origins of language (if such an understanding is possible). (Prof. Jóhannesson's fourth 'stage' is the development of words with abstract meaning from those with concrete meaning.) That sounds of the first two classes exist in all languages no one will deny. Nor need we be surprised at the similarity between English 'nanny', Turkish *nini* (mother) and Greenlandic *an-âna* (mother); nor at that between English 'ting-a-ling', Turkish *tingirtingir* (sound of metallic things knocking together), and Archaic Chinese *ting-ning* (a small bell). The words collected (under the heading of emotional sounds) showing the connexion of the *n*-sound with meanings of "blowing" or "breathing" (and hence "the soul") are impressive in number. But when under the gestural meaning of 'curved', 'round', 'swollen' are collected words having such diverse meanings as 'grave', 'conceal', 'cover', 'ivy', 'hair', 'be dark', 'cut', 'neck', 'cub', as well as more obvious ones like 'fat', 'tumour', one wonders whether this is not all too remote ever to be convincing.

University Grants Commission Bill in India

THE Government of India has introduced a Bill in the Lok-Sabha called the University Grants Commission Bill, 1954; this has now been referred to a Joint Select Committee of Parliament. It has been claimed that such a Bill was long overdue as universities in India have greatly suffered in the past from neglect (*Sci. and Cult.*, **20**, No. 9; March 1955). Except for the Universities of Delhi, Banaras, Aligarh and, lately, Visva-Bharati, where financial responsibility rests on the Central Government, other universities, many of which are much larger and much older than these, have not received any considerable funds from the central government. They have to rely on funds provided by the respective States and these are far below their requirements. With the increasing tempo of national development in all spheres and with the growth of new knowledge in science and technology all over the world, the universities in India have to enlarge their field of education and research if they are to discharge their responsibilities to the nation. A Bill, therefore, which would enable the formation of a Statutory University Grants Commission, supplied with adequate funds by the Government of India and clothed with appropriate authority, is most welcome.

Durban Museum and Art Gallery: Annual Report

THE annual report for the year 1953–54 of the Durban Museum and Art Gallery (pp. 15; 1955) records the opening of the Old House Museum by the Administrator of Natal, Mr. D. G. Shepstone, on June 12, 1954. This Museum is devoted entirely to the preservation and display of historical material associated with the Province of Natal. The 'Old Durban' Room in the central Museum forms the nucleus, and the various and extensive collections gathered together by the South African National Society (Durban Branch) are likewise centred at the Old House. The year also witnessed the virtual completion of the new gallery of South African birds with its complement of thirty-six habitat groups.

International Society for Human and Animal Mycology

THE International Society for Human and Animal Mycology was founded last year by a group of scientific workers from ten countries. Its objects are to bring together qualified persons interested in the study of fungi living on humans and animals; to encourage the formation of regional groups of these persons; to organize meetings of the members of the Society on the occasion of international congresses; and to publish, as soon as possible, a bulletin devoted to human and animal mycology. The committee of the Society is as follows: *President*, P. Redaelli (Milan); *Vice-Presidents*, C. W. Emmons (Bethesda, Maryland), G. T. Ainsworth (Exeter), P. Negroni (Buenos Aires) and G. Segrétain (Paris); *General Secretary*, R. Vanbreuseghem (Antwerp). Persons wishing to join the Society should write to the General Secretary at the Institut de Médecine Tropicale, 155 rue Nationale, Anvers.

University of Glasgow

THE following appointments have been made in the University of Glasgow: *Lectureships*, P. de Mayo, K. H. Overton and R. P. A. Sneeden (chemistry) and A. M. Andrew (physiology (electronics)); *Imperial Chemical Industries, Ltd., Fellowships*, E. Corinaldesi and P. V. March (natural philosophy) and E. Seoane (chemistry); *Nuffield Fellowships in Genetics*, C. G. Elliott (a reappointment) and Etta Kafer. Dr. S. C. Curran has resigned from the Department of Natural Philosophy in the University on his appointment as head of the Division of Radioactivity, United Kingdom Atomic Energy Authority, and Dr. A. N. MacPhail from the Department of Public Health, on his appointment to the chair at University College, Khartoum. Work has been commenced in the University on the extensions to the engineering buildings that are to occupy ground most of which was formerly occupied by the old chemistry buildings.

Lady Tata Memorial Trust: Awards

THE following new awards have been made by the Lady Tata Memorial Trust for research on leukæmia and allied diseases during the academic year 1955–56: *Scholarships* (*whole-time or part-time*), Prof. H. G. Teir (Department of Pathology, University of Helsinki) and Dr. C. G. V. Wasastjerna (Department of Hæmatology, Maria Hospital, Helsinki); *Personal grant*, Mr. Stanislaw Joseph (Department of Human Anatomy, University of Oxford). In addition, a block grant has been made to the Social Medicine Unit, University of Oxford (Dr. Alice Stewart, director), for the cost of a pilot inquiry into possible environmental factors in the ætiology of leukæmia in man. Various awards first made to the following in previous years (see *Nature*, **171**, 1098 (1953), and **173**, 1170 (1954)) have been renewed for a further year:

Dr. J. Kieler (Copenhagen), Dr. J. Nordmann (Paris), Dr. A. Sreenivasan (Bombay), Dr. F. Kissmeyer-Nielsen and Dr. N. A. Stenderup (Aarhus), Dr. J. Ringsted and Dr. J. Rygaard (Copenhagen), and Dr. Maxime Seligmann (Paris).

Conference on the Physiology of the Invertebrates

A conference on "Recent Advances in the Physiology of the Invertebrates", sponsored by the United States National Science Foundation, the Tektronix Foundation and the University of Oregon, will be held at Eugene, Oregon, during September 12–16. The conference was initiated by A. W. Martin, of the University of Washington, and has been organized by a committee composed of Martin, L. H. Kleinholz (Reed College), B. T. Scheer (University of Oregon) and T. H. Bullock (University of California). Eugene was selected as the meeting place because the administrative body of the University of Washington refused permission for a lecture by Dr. J. Robert Oppenheimer. The conference will consist of a series of reviews of recent work in invertebrate physiology, followed by informal discussions, the invited speakers including, besides the committee members and others, F. A. Brown, jun., J. S. Pringle, J. D. Robertson, T. H. Waterman, C. A. G. Wiersma and K. M. Wilbur. The papers will be published by the University of Oregon. A visit will be made to the Oregon Institute of Marine Biology at Charleston. Further information can be obtained from Prof. B. T. Scheer, Department of Biology, University of Oregon, Eugene.

Twelfth Congress of the International Association of Applied Psychology

The twelfth congress of the International Association of Applied Psychology will be held in London in the University Senate House and in Birkbeck College, both of which are in Malet Street, London, W.C.1, during July 18–23, under the presidency of Dr. C. B. Frisby. Besides a large number of symposia on specialized topics and the reading of individual papers, four general lectures will be given as follows: Sir Frederic Bartlett (Cambridge), on timing—a fundamental character in human skill; Prof. L. L. Thurstone (North Carolina), on the theory and application of a subjective metric; Prof. C. Pellizzi (Florence), on the European Productivity Agency; and Dr. E. Mira y Lopez (Rio de Janeiro), on the influence of foresight and attitude on mental output. Visits will be made to a number of psychological organizations and hospitals in London, Cambridge, Oxford and Windsor. Further information can be obtained from the secretary of the congress. Mr. Alec Rodger, 14 Welbeck Street, London, W.1.

Canadian Association of Physicists: Tenth Annual Congress

The tenth annual congress of the Canadian Association of Physicists will be held in Toronto during June 20–24 in conjunction with the June meeting of the American Physical Society; the last three days of the congress will be devoted to the programme of the latter body. On June 20 the Canadian Association will hold a symposium on radiations as applied to medicine, under the chairmanship of Prof. J. K. Robertson (emeritus professor of physics, Queen's University, Kingston, Ontario), and on the following day there will be another symposium on "Physics in Industry", under the chairmanship of Dr. L. Kerwin (Laval University, Quebec). On the same day Dr. Kerwin will give his address as president of the Association, his subject being "The Next Decade for C.A.P.", and in the evening Dr. R. T. Birge (president of the American Physical Society) will give an after-dinner address on "Science and Pseudo-Science".

Fourth National Clay Conference in Pennsylvania

The Fourth National Clay Conference will be held in the Pennsylvania State University at University Park during October 10–13, this being the first time that it has met in the Eastern United States. The period coincides with the centennial celebration of the Pennsylvania State University, and arrangements have been made for several scientific workers from Europe and Asia to attend and present papers describing work in their own countries. In the past the Conference has attracted a very diverse group of scientists ranging from colloid and ceramic chemists to mineralogists and soil scientists. Further information can be obtained from the chairman of the local committee, Prof. T. F. Bates, College of Mineral Industries, Pennsylvania State University, University Park, Pa.

Announcements

Prof. René Fabre, professor of toxicology and dean of the Faculty of Pharmacy, University of Paris, has been elected a member of the Rural Economy Section of the Paris Academy of Sciences in succession to the late A. Demolon.

Prof. F. V. Atkinson, professor of mathematics in University College, Ibadan, has been appointed professor of mathematics in Canberra University College.

Prof. A. P. Guinaud, associate professor of mathematics in the Royal Military College of Science, Shrivenham, has been appointed professor of mathematics in the University of New England, Armidale, New South Wales.

The Istituto Lombardo di Scienze e Lettere is arranging to hold the first Antonio Baselli Conference at Pallanza during July 28–30. The subject will be "The Macromolecules of the Organism". Those wishing to attend should write to the Secretary of the Istituto Lombardo, via Brera 28, Milano, from whom further information can be obtained.

The Northern Division of the Institution of Electronics will be holding its tenth annual electronics exhibition in the College of Technology, Manchester, during July 14–20. More than fifty organizations will be exhibiting, divided between a scientific and industrial research section (composed of displays from the research associations and laboratories, government establishments, universities, hospitals, etc.) and a manufacturer's section. Forty lectures and sixteen film shows will be given. Admission tickets both to the lectures and the exhibition, together with any further information, can be obtained from the honorary organizing secretary of the exhibition, W. Birtwistle, 78 Shaw Road, Thornham, Rochdale, Lancs.

The United Kingdom Papers Committee has completed its official list of those attending the International Conference at Geneva during August on the Peaceful Uses of Atomic Energy. It is still possible, however, for any further interested persons to apply for seats in the public gallery. Applications should be made direct to Dr. Adrian Pelt, Director, European Office of the United Nations, Palais des Nations, Geneva.

NEW PHYSICS LABORATORIES AT UNIVERSITY COLLEGE, LONDON

THE new Physics Wing at University College, London, was officially opened on May 4 by Sir James Chadwick, in the presence of some five hundred guests widely representative of the scientific, industrial and teaching life of the community.

The opening of this new building marks the completion of the first stage in the provision of permanent accommodation for the Physics Department after the destruction suffered during the Second World War. It provides something less than half the floor space which, it is envisaged, will eventually be made available to the Department.

The building, which has six floors, was designed by Prof. A. E. Richardson and built by Messrs. Dove Bros., Ltd. It is of steel frame construction faced mainly with Kentish stock brickwork, but has Portland stone up to the ground-floor level and stone dressings around the windows. The roof is of concrete, insulated with cork and covered with copper. In order to save the cost of periodical repairs, the window sashes are constructed of aluminium, specially treated to resist corrosion. Invisible steam pipes embedded in the ceilings provide heat for the building. Three rows of steel channel inserts fixed flush to the surface of all available wall space provide ready means for suspension and temporary fitting of apparatus.

Three of the six floors are devoted mainly to research, and the remaining three floors to teaching laboratories. These undergraduate laboratories, situated on the first, second and third floors, can accommodate all the undergraduate practical training, except for an elementary class still housed in an older part of the College. Accommodation is provided for about thirty-five students in each of the three years of the course for the B.Sc. (Special) degree in physics as well as for a somewhat larger number of students who take a two-year course in physics ancillary to chemistry or astronomy. A number of students reading physics for the B.Sc. (General) degree are also accommodated.

Each of the undergraduate laboratories occupies a floor space of 4,600 sq. ft. and includes dark rooms for optical experiments, extensive apparatus stores and technicians' rooms. In addition, there are fully equipped photographic dark rooms, a balance room, and workshop facilities for the use of undergraduate students. There are some sixty or seventy student benches in each laboratory, and points for gas, water and electrical power are liberally distributed.

Particular care has been taken with the design of facilities for the third-year student laboratory. It has been the custom at University College for several years now to encourage third-year undergraduate students of experimental physics to develop their originality by tackling more elaborate experiments than they have attempted previously. They are given small experimental projects in which they gain experience in the design and construction of apparatus and in solving problems relating to its working. While these experiments cover a wide range of topics, considerable emphasis is placed on electronics.

It is interesting to recall that the first courses in practical physics arranged for undergraduate students in any English university were given at University College in the session 1866–67 on the initiative of Prof. Carey Foster. The new teaching laboratories should provide adequate facilities to enable the traditions of the College in the teaching of practical physics to be worthily maintained.

Turning now to the research facilities provided by the new building, these are housed on the lower ground floor, the ground floor and the fourth floor.

The lower ground floor has a ceiling 16 ft. 6 in. high, and the greater part of the floor is occupied by the electron accelerator laboratory, which extends along the whole length of the floor and over about two-thirds of the width. An overhead travelling crane runs the full length of this laboratory, which is at present divided into three rooms by temporary partitions.

A microtron (electron cyclotron) accelerator producing a mean extracted current of 0·5 μamp. of electrons at 5 MeV. energy has been constructed and is in full operation. A larger microtron to provide 25-MeV. electrons is under construction and will also be installed on the lower ground floor. Both these machines are to be used in an extensive study (already in progress) of fast-electron scattering by nuclei.

The lower ground floor also houses a store, glass-blowing shop, dark rooms, a spectroscopic laboratory, and a room for storing and handling small quantities of radioactive isotopes.

The ground floor contains a number of private staff rooms and offices; but research laboratories comprise the greater part of this floor also. Most of the research in progress on this floor is devoted to the experimental study of electronic and ionic collisions. Systematic investigations are in progress on the exchange of charge or excitation, on ionization, and on elastic scattering produced when beams of ions or metastable atoms are passed through gases. Extensive work is also concerned with collision processes in atomic hydrogen and with studies of gaseous discharges. Gas, water, compressed air and oxygen services are installed throughout the ground and lower ground floors, as well as an adequate supply of d.c. and a.c. (both single- and three-phase) points.

The top floor, in addition to providing office accommodation for members of the staff and for research students specializing in theoretical physics, houses the departmental library, a small lecture room used particularly for seminars, and the computing laboratory. An electronic computer designed by Dr. A. D. Booth, of Birkbeck College, is now being installed in the computing laboratory. In addition to providing for the needs of the theoretical research in the Department, it is intended that when fully in operation the facilities of this machine will be made available to other departments of the College and University.

The number of research workers in the Physics Department at University College is large. There are some fifty postgraduate Ph.D. students, while there are altogether 78 research workers in the Department. Only some of these are accommodated in the new wing, however. The research groups working on the high-pressure cloud chamber, high-energy nucleon scattering and the electron lens

for electron and positron scattering are still housed in temporary quarters. It is hoped that eventually all the rest of the research work of the Department as well as the workshop and lecture theatres will be accommodated in an adjacent building under conditions as satisfactory as those of the new wing.

THE PHARMACEUTICAL SOCIETY

ON May 23, the Pharmaceutical Society of Great Britain held a reception to mark the granting of its new constitution. Founded in 1841, the Society received a Royal Charter in 1843. Modifications were afterwards made in its constitution by the various Pharmacy Acts. A Supplemental Charter granted in 1953, virtually replacing the original, and the Pharmacy Act 1953 have now brought the Society's constitution into line with present-day circumstances and needs. A reception was held at 66 Portland Place, W.1, through the kindness of the Royal Institute of British Architects, to mark the occasion, and H.R.H. the Duke of Edinburgh attended the reception and was presented during the evening with his diploma as the first Honorary Fellow of the Society.

The Society's charters and grant of arms were on view, together with rare books from the Society's Library. *Incunabula* were represented by the "Latin Herbarius" printed at Passau in 1485, and the 1491 edition of the "(H)ortus Sanitatis" from the press of Jacob Meydenbach at Mainz. The latter, a treatise on herbs, animals, birds, fishes, stones and minerals, showed the illustration of the Bausor tree, believed to exhale a narcotic poison. In the illustration two men lie beneath its branches, apparently in the sleep of death. Manuscripts included an early recipe book in Elizabethan hand and a fine English medical work of the seventeenth century, bound in contemporary calf. A copy of the second issue of the first "London Pharmacopœia" of 1618 published in December of that year attracted much interest. The first issue was published in May, but it was so full of errors that all copies were officially destroyed; a facsimile of it was exhibited. The first quarto edition, published in 1699, of the well-known satirical poem "The Dispensary", by Dr. Samuel Garth, dealing with the quarrels between the Society of Apothecaries and the Royal College of Physicians, was also on view.

At the request of the Duke of Edinburgh, an exhibition had been staged to portray the pharmaceutical industry's contribution to medical and veterinary science.

Featured on twenty large panels, arranged by the Association of the British Pharmaceutical Industry, was a representative selection of the drugs discovered and developed in recent years, which have revolutionized the practice of medicine and have made a significant contribution to advances in surgery.

In an introductory panel, some statistics of the industry were shown graphically. Its production, valued at £19 million in 1935, had risen to £120 million in 1954. The numbers of persons employed by the industry in research, development, manufacture both primary and secondary, and in distribution to the pharmacist, doctor and hospital, had risen much less than proportionately—from 22,000 in 1935 to 53,000 in 1951. Its exports, valued at £3·28 million in 1938, amounted in value to £33·6 million in 1954.

The tendency to think of modern medicine in terms of sulphonamides, antibiotics and other recently discovered life-saving drugs often leads to the supposition that symptomatic treatment no longer has a place in medicine. As a reminder that preparations of vegetable drugs and their active principles are still used in considerable though steadily diminishing amounts, a panel was included featuring a flow chart of the manufacture of a galenical, photographs of fields of henbane, foxglove (digitalis) and deadly nightshade (belladonna), together with specimens of an opium poppy capsule, gentian root, nux vomica seeds, ergot sclerotia, and preparations of digitalis. Roots of *Rauwolfia serpentaria* and its principal alkaloid reserpine, now much used for mild hypertension and psychotic disorders, were also shown. The commercial development of the synthesis of atropine and the tropane alkaloids was illustrated by a photograph of the British plant now used for this purpose.

The developments in anæsthesia since Sir James Young Simpson introduced the use of chloroform in Edinburgh in 1847 were exemplified by the newer anæsthetics such as cyclopropane, trichloroethylene (including its application by self-administration) and thiopentone (used intravenously).

Muscle relaxants, which have a temporarily paralysing action and greatly facilitate modern surgery by avoiding the need for almost toxic doses of anæsthetic, derive their application from the isolation of the alkaloid tubocurarine from the South American arrow poison, curare. Poison-tipped darts and blowpipe, crystalline curare and a curare gourd prefaced specimens of tubocurarine and the more recently developed synthetic analogues, gallamine triethiodide and laudexium methylsulphate.

The development of specialized contrast media by the British pharmaceutical industry has enabled the medical use of X-rays to be extended, and in addition to the detection of bone fractures they now aid the radiologist to give a prominent picture of the gall-bladder, arteries, bronchial tree, the urinary tract and other systems and organs. Among the radiological agents displayed were barium sulphate for preparation of barium meals, diodone, iodized oil, propyliodone, iodoxyl and ethyl iodophenylundecylate.

The use of injectable fluids to restore blood volume in cases of patients suffering from shock and loss of blood, as an alternative to the transfusion of blood, began with the discovery of the value of gum acacia-saline injection during the First World War. Dextran and polyvinylpyrrolidone were exhibited as newer agents which avoid the adverse effects of acacia-saline on the blood and liver. They are polymers of sufficiently high molecular weight not to be excreted too quickly.

The antibiotics formed the subject of two panels and exhibits. A photograph of the late Sir Alexander Fleming fittingly introduced the panels, which included a flow chart of penicillin manufacture, a chart depicting the rate of growth of manufacture and export of penicillin and its preparations, and another showing the estimation of sensitivity of organisms to antibiotics. Specimens shown of the different forms of presentation of penicillin included vials of penicillin *G* for preparation of the injection, of procaine penicillin, of oral suspension, tablets and ointment, and of penethamate hydriodide and benethamine penicillin. Specimens were also shown of streptomycin sulphate, chloramphenicol capsules, aureomycin, oxytetracycline, tyrothricin lozenges, polymixin-bacitracin ointment, neomycin, viomycin,

and erythromycin. The application of antibiotics as supplements in animal feeding to increase the rate of growth of animals was illustrated by photographs of piglets at different ages after so feeding.

Antihistamines exhibited included diphenhydramine, mepyramine, promethazine, antazoline, chlorcyclizine and phenindamine, together with a diagram of the action of antihistamines and a reminder of their value in preventing travel sickness and nausea and vomiting due to other causes. It was only in 1910 that Sir Henry Dale, then working in the research laboratories of a British pharmaceutical company, had fully investigated histamine, a natural constituent of the living tissues, and the liberation of which is largely responsible for allergic manifestations. It was only subsequent to 1910 that the search for histamine antagonists began. For some years the main histamine antagonist was adrenaline. More recently a homologue, isoprenaline, has been much used as its sulphate. What are now called 'antihistamines' have the more specific action of neutralizing directly the physiological effects of histamine.

Anticoagulants which have revolutionized the treatment of thrombo-embolic disease interfere with the process of coagulation of the blood, a process illustrated by a chart. The exhibits included the naturally occurring heparin, extracted from lung or liver tissue, the synthetic anticoagulants, dicoumarol and its derivatives, phenylindanedione, as well as dextran sulphate discovered by Ricketts and Walton at Birmingham.

The importance of antimalarials was illustrated by a map showing the world incidence of malaria, and a chart illustrating the life-cycle of the malaria parasite and photographs showing methods of eradication of mosquitoes. Antimalarials exhibited included quinine both as tablets and injection, amodiaquine, pyrimethamine, chloroquine, primaquine and proguanil.

Some of the problems of tropical medicine were illustrated by photographs of patients suffering from elephantiasis, leprosy, bilharzia and trypanosomiasis, and by a table showing the carriers of and parasites responsible for these diseases and the modern methods used for their treatment. A tank of snails served as a reminder of the problems of eradication of bilharzia from endemic areas. Specimens of medicaments shown included the anti-leprotic sulphones, tryparsamide, lucanthone, sodium stibogluconate, diethylcarbamazine, suramin, pentamidine isethionate and yellow-fever vaccine.

A panel devoted to veterinary medicine emphasized the application of the newer human remedies to the treatment of animal diseases, as well as the development of specific serological products. Limitations of space scarcely permitted justice to be done to the contributions of the industry to the advances in animal medicine.

A portrait of Lord Lister introduced recent developments in antiseptics, which were exemplified by specimens of acridine derivatives, halogenated phenols such as chloroxylenol, *p*-chloro-*m*-xylenol and -cresol, and the quaternary ammonium compounds cetrimide, benzalkonium and domiphen bromide.

The progress in the British development of insulin manufacture since Banting and Best's discovery of insulin in 1922 was dramatically illustrated by a chart of the price reductions that have followed its increasingly large-scale production to meet the demands of diabetics throughout the world. Charts showed the duration of reduction of blood sugar by soluble insulin and its complexes with globin and protamine in the presence of zinc and of the more recently developed insulin zinc suspensions.

Other hormones and their derivatives exhibited included testosterone, methyl testosterone, œstrone, ethinylœstradiol, stilbœstrol and cortisone acetate (manufactured in Britain from hecogenin isolated from sisal). Supporting charts showed the chemical inter-relationships of the medicinally used steroids and the influence of hormones in the menstrual cycle.

Immunological products were introduced by a portrait of Jenner, a chart showing the changed incidence of diphtheria in recent years and photographs of sera manufacture, the preparation of B.C.G. vaccine and inoculation of culture media. In addition to specimens of different sera and vaccines, there were shown publicly for the first time specimens of the Salk antipoliomyelitis vaccine manufactured by a British firm.

Specimens of an almost complete range of the vitamins used medicinally, including about a gram of crystalline cyanocobalamin (vitamin B_{12}), supported illustrations of vitamin-deficiency states and of plant employed in the manufacture of certain vitamins by synthetic methods.

Following Domagk's discovery of the value of prontosil in chemotherapy, and of Fourneau's recognition that the sulphanilamide fragment was wholly responsible for its action, the synthesis and evaluation of sulphapyridine by a British firm set the pattern for the highly effective sulphonamides now used in chemotherapy. Despite the introduction of antibiotics, the sulphonamides are still widely used in the treatment of many diseases and have aided in the avoidance of, and in dealing with, drug-resistant strains of organisms. A photograph of Dr. A. J. Ewins introduced a panel depicting various aspects of sulphonamide evaluation and therapy, and specimens of sulphonamides displayed included sulphadiazine, sulphadimidine, sulphafurazole, sulphamerazine, sulphathiazole, phthalyl- and succinylsulphathiazoles, sulphaguanidine, sulphasomidine and sulphacetamide both in powder form and in tablets.

The assistance given by analgesics and hypnotics in coping with the exigencies of modern civilization have led to the search for, discovery and manufacture of, the wide range of barbiturates, specimens of short-, medium- and long-acting ones being shown. Although substantial quantities of morphine are still manufactured and used, synthetic analogues such as pethidine, of which a specimen was shown, are steadily replacing morphine in many of its applications.

The skills of the organic chemist, the pharmacologist, the biochemist, the bacteriologist, the microbiologist and the chemical engineer are of little avail to modern medicine unless the products emerging from their work are presented in stable, effective and acceptable form for use by the patient or medical practitioner. It is to the formulation, preparation and directions for use of the whole range of medicaments that the pharmacist applies his training and knowledge. It was therefore fitting that the final exhibit should be devoted to specimens of the forms in which medicaments are used: tablets, pills, capsules, ampoules and multiple-dose injection containers, suppositories, bougies, pessaries, cachets, lozenges, pastilles, creams, ointments, dusting powders, mixtures, syrups, mouth washes, paints, liniments, lotions and eye drops.

CONDENSATION NUCLEI

SYMPOSIUM IN DUBLIN

A SYMPOSIUM on condensation nuclei was held in the School of Cosmic Physics, Dublin Institute for Advanced Studies, during April 26–28, when thirty-four delegates from eight countries participated and twenty-six papers were presented. The five half-day sessions dealt with the meteorology, climatology and aerology of nuclei, new instruments and methods for recording their concentration, measuring their size, density and mass, their biological role and importance for research in hygiene and the production of nuclei under special conditions.

The relationship between the concentration of atmospheric nuclei measured with a photo-electric counter twice daily over a four-year period at Valentia Observatory and meteorological elements has been investigated by S. McWilliams and W. A. Morgan (Ireland). The majority of observations gave a count of less than 500 nuclei cm.$^{-3}$; the concentration generally decreased with increasing relative humidity and the annual variation followed fairly closely that of duration of bright sunshine.

M. Bider (Switzerland) presented a similar investigation for Basle based on continuous records obtained by means of the automatic Verzár photo-electric nucleus counter. Since this recorder measures concentration every fifteen minutes, many problems can be tackled which with eye observations at a few fixed hours could not be approached. The increase of concentration with sunshine established near the Atlantic at Valentia was also found at Basle. Simultaneous records with identical Verzár automats in the centre of the city and on the outskirts at a distance of 1·5 km. have shown that the average concentration in the centre (46,000 nuclei cm.$^{-3}$) is about eight times that on the outskirts. In spite of this very large difference in the concentrations, the variation at both stations was strikingly similar.

G. J. Day (Meteorological Research Flight, Farnborough) delivered a preliminary report on measurements of condensation nuclei made with a direct-beam photo-electric counter during ten aeroplane ascents over the British Isles in mainly anticyclonic situations. He found that clean maritime air passing over unbroken sea surfaces contains about 200 cm.$^{-3}$ nuclei at normal cloud-base levels (approximately 2,000 ft.), though it often contains as many as 3,000 cm.$^{-3}$ nuclei in the lowest few hundred feet. Over broken sea surfaces values of 1,000 cm.$^{-3}$ nuclei are found throughout the turbulent mixing layer, so that it appears that sea salt nuclei contribute a large, though not a major, part to the nucleus population. At heights of 1,000–2,000 ft., during flights covering most of England and including some circumnavigations of Greater London, a normal concentration of about 2,000 cm.$^{-3}$ nuclei was found which rose to 5,000 cm.$^{-3}$ nuclei over large domestic and industrial centres. Contrary to expectation, no increase in the general level of concentration downwind of large contaminating centres such as London was found. However, downwind of specific sources within such areas, concentrations of tens of thousands of nuclei per cm.^{3}, often thirty thousand, were observed. These localized increases seem associated with a relatively few sources and must presumably be associated with specific industrial processes.

Mrs. Rita Callahan Sagalyn (United States Air Force Cambridge Research Center) reported on concentration, mobility and distribution of charged nuclei in fair weather and in the altitude-range 500–20,000 ft. These investigations over the United States and the Atlantic Ocean were carried out together with G. Faucher in a *B*-17 aeroplane converted into a veritable flying observatory. A series of diurnal measurements made over a fixed flight-path indicates the importance of turbulence and air-mass changes for the distribution of nuclei in the atmosphere.

New ingenious methods for counting nuclei, which J. C. Thams and W. Wieland (Locarno-Monti) have recently developed, were described and illustrated by Dr. Bider. The droplets formed by expansion in an Aitken–Scholz counter, and even the nuclei themselves before forming cores of droplets, are caught on slides coated with a thin (0·01 mm.) layer of copal lacquer in which they produce holes. The counting of the holes is rapidly carried out by a photo-electric device.

Great progress in recording nuclei concentration is noticeable in the second version of the automats designed by F. Verzár (Basle) and the construction by R. Siksna (Uppsala). Both elaborate automats employ the direct-beam photo-electric principle, and the latter in addition uses continuous photographic recording of the droplets in an Aitken-type counter. R. Mühleisen's (Western Germany) new recorder for nuclei concentration with continuous over-saturation, which hitherto had escaped general notice, has the advantage of recording concentration in one-minute intervals.

Recently in meteorology there has been a tendency to seek information on the size of the condensation nuclei and their nature as well as their concentration. A variation of the photo-electric nucleus counter to obtain size discrimination was demonstrated by T. A. Rich (General Electric Company, United States). The sample at atmospheric pressure in the fog-tube of the counter is expanded into two evacuated containers: into one as rapidly as possible, into the other slowly enough to permit the growth of water drops and yet fast enough so that the expansion is essentially adiabatic.

Preliminary tests of a new method for measuring the size, density and mass of condensation nuclei which L. W. Pollak and T. C. O'Connor (School of Cosmic Physics, Dublin) have designed for investigating the quickly changing atmospheric aerosol, particularly during aeroplane flights, are encouraging. The underlying theory of this 'static' method was developed by R. Fürth (Birkbeck College, University of London). Utilizing standard equipment and measuring the decreasing concentration of condensation nuclei when enclosed in a small cylindrical container, it is possible to determine from two measurements of concentration the size of the nuclei and from three such measurements their size, density and mass.

P. J. Nolan and E. Kuffel (University College, Dublin) dealt with the decay of enclosed nuclei. They found with ultra-small nuclei that the coefficient of the linear diffusion term in the decay equation varies as the square root of the diffusion coefficient. The production of nuclei from ammonia and nitric acid were discussed by P. J. Nolan and E. Kuffel; that of uncharged nuclei by ultra-violet light formed the subject of a most interesting paper by J. R. Atkinson (Glasgow), whose results are also of importance for users of cloud chambers.

The retention of condensation nuclei in the respiratory tract was dealt with by F. Verzár and P. J. Nolan. Based on experiments made by T. Burke and himself, Nolan stated that nuclei are not produced by breathing. Exhaled air contains 80–20 per cent of the nucleus content of the inhaled air. Mr. Claes Rooth summarized most ably the important work by C.-G. Rossby (Stockholm) and H. Egnér (Uppsala) on the synoptic variations in the chemical composition of atmospheric precipitation and made a strong plea for introducing measurements of carbon dioxide as a routine in meteorological networks.

In the geophysical laboratory of the School of Cosmic Physics, Dublin, equipment for determining concentration and size of condensation nuclei and for measuring their vertical gradient near the ground were demonstrated during the symposium. A small exhibition showed the development of the photo-electric nucleus counter. Among the exhibits were a photograph of the direct-beam photo-electric nucleus counter, and the original model of the multiflex photo-electric counter which L. W. Pollak designed and W. A. Morgan constructed in the offices of the Irish Meteorological Service at Foynes early in 1940. The proceedings of the symposium will be published as a separate volume of *Geofisica Pura e Applicata* (Milan). The next symposium on condensation nuclei is to take place in September 1956 in Switzerland.

L. W. POLLAK

TAPEWORMS OF THE FAMILY TETRABOTHRIIDAE

AN interesting and important paper by Prof. J. G. Baer has been published as a memoir of the University of Neuchâtel* on a taxonomic revision and biological study of the Cestodes of the family Tetrabothriidae parasitic in birds of the high seas and marine mammals. In the paper, Prof. Baer aims at classifying and simplifying the determination of this very difficult group of tapeworms, and seeks to show—with considerable success—that a parasite and its host are fundamentally inseparable. The two must be considered together.

The revision is based on the re-examination of more than seventy types of the eighty-odd species described, with the result that the number of species is reduced to forty, and only four of the eleven genera are retained. The monograph is divided into five sections, the first three of which are entirely given up to the descriptions of the species together with their synonyms, hosts and the more important bibliographical references. An introductory chapter deals with the general anatomy, and it is found that neither the size of the scolex nor the muscular development of the strobila are reliable taxonomic characters, as was formerly supposed to be the case. On the other hand, the structure of the genital atrium is stressed since it appears to yield by far the best and most reliable morphological character. This structure, however, can only be seen in transverse sections, and therefore no specific identification is possible if worms are mounted *in toto*. All the species are described in a uniform manner, and only the essential characters are stressed. The genital atrium of each species is illustrated, and all the drawings made to the same scale, so that comparisons are easily made, while a special section is devoted to the comparative anatomy of the species. It is found that the structure of the genital atrium reveals the existence of three distinct evolutionary trends, making it possible to split the species into distinct groups. A key for the identification of the species is thus established. The position of the family Tetrabothriidae is discussed and it is assigned to a new order, distinct from either the Pseudophyllidea or the Cyclophyllidea, but more closely related to the Tetraphyllidea.

Tetrabothriids are found to be extremely host-specific; each group of hosts—namely, Sphenisciformes, Procellariiformes, Pelecaniformes, Gaviiformes and Charadriiformes—harbours species distinct from those occurring in the others. Although the life-cycle of the tapeworms is unknown, it is postulated, on the basis of stomach contents of the sea-birds and mammals, that cephalopods might act as intermediate hosts. From statistical evidence it seems that the host can only become infested when leading a semi-sedentary life, that is, during the breeding season. This is also borne out by the fact that different hosts belonging to the same order nesting on the same island usually harbour the same species of tapeworm. Using the evolutionary trends of the genital atrium as a basis, combined with the results obtained from a statistical study of the distribution of the parasites among the hosts, it is found that there is distinct evidence of parallel evolution of both the tapeworms and their hosts. From these results it is postulated that the Sphenisciformes, Procellariiformes and Pelecaniformes might be derived from a common stock, and the Gaviiformes and the Alcae appeared later as side branches. The arguments and evidence put forward here by Prof. Baer are convincing, and one feels that his main conclusions are right. He also suggests that the species harboured by gulls have been acquired secondarily. But here he is not quite so confident; the case is certainly more open to argument, and one wonders if perhaps only one of the gull lines has been acquired thus.

I think, however, that Prof. Baer rather over-emphasizes (p. 104) the apparent contradiction in the conclusions he reaches from the study of Tetrabothriids and the evidence deduced from a study of the Mallophaga. True, his conclusions are not entirely confirmed by the published work on the feather lice, but this is largely owing to the fact that evidence from the distribution of the Mallophaga is rarely helpful in the elucidation of the relationship between orders of birds. Thus the Mallophaga of the Sphenisciformes and Gaviiformes show no apparent relationship to those of other birds. While, although some of the Mallophaga of the Procellariformes, Pelecaniformes and Charadriiformes do not rule out a possible relationship between these orders, the evidence is in no way conclusive.

Finally, it must always be remembered that the classification of the birds themselves is in some cases still open to doubt, and the characters upon which families are assigned to certain orders may be less dependable than the characters chosen for classifying their parasites. Unfortunately, specialists are not often in a position to evaluate the classification of groups other than their own, and are chary of taking

* Révision taxonomique et étude biologique des Cestodes de la famille des Tetrabothriidae parasites d'oiseaux de haute mer et de mammifères marins. By Jean G. Baer. Mémoires de l'Université de Neuchâtel, Série in-quarto, 1; 1954. Pp. 123+82 figs. (Neuchâtel, 1954.) 20 Swiss francs.

so much on trust. If Prof. Baer has discovered in the genital atrium a character which is dependable—a point which time alone will prove to everyone's satisfaction—it is a matter of great importance from the point of view of elucidating host/parasite relationships.

One minor point is worth noting: a fine trap is set for the English-speaking reader by the use here and there of vernacular names of the hosts. Thus, "Pingouin" equals razorbill, not penguin, and "Puffins" are shearwaters, not puffins in our sense.

Miriam Rothschild

RADIO EMISSION FROM JUPITER

THE Carnegie Institution of Washington announced in April that radio emissions from Jupiter had been detected on a frequency of 22 Mc./s. The receiving system consisted of a large cross aerial, of the type developed by Mills in Sydney for radio astronomy, which produces a narrow beam in a fixed direction. The Carnegie aerial occupies a 96-acre field near Seneca, Maryland, and although the beam-width is not stated it may be deduced to be of the order of one degree from the fact that Jupiter passes through the aerial beam in six minutes. The radio emissions were reported to have the appearance of short random bursts of static resembling thunderstorm interference on a broadcast receiver and were observed about one day out of three during the time when Jupiter was in the beam of the aerial system. The location of the sky from which these bursts originated agreed with the position of Jupiter over a period of several months, and hence it can be presumed that any terrestrial origin of the bursts has thereby been excluded.

The study of radio waves from the sun is a well-known and important part of radio astronomy. The signals are relatively intense; those from the quiet or undisturbed sun originate in the corona, which has an equivalent black-body temperature of the order of a million degrees at these low frequencies. Success has also been achieved in measuring the radio emission from the moon by Dicke and Beringer in 1946, and by Piddington and Minnett in 1949. In this case the emission measured, on a wave-length of 1·25 cm., corresponds to the black-body radiation appropriate to a lunar surface temperature of 250° K. The surface temperature of Jupiter measured at the top of the cloud layer is about 160° K., and hence the signal bursts received by the Carnegie workers on 22 Mc./s. must have quite a different origin from the solar or lunar emissions.

It has been suggested that the Jupiter signals are caused by disturbances in the planetary atmosphere similar to terrestrial thunderstorms, but on a much larger scale. It is possible to estimate the likelihood of this from the radiation field produced by a single lightning flash in the earth's atmosphere which, according to the measurements of E. T. Pierce, is 15 V./m. at a distance of 20 km. on a frequency of 1 Mc./s. and band-width 1 Mc./s. At the distance of Jupiter the field-strength would be 5×10^{-7} V./m. and the power flux about 10^{-21} W. m.$^{-2}$ (c./s.)$^{-1}$ at 1 Mc./s. Making reasonable assumptions about the frequency spectrum and remembering that in the terrestrial atmosphere the rate of occurrence is about a hundred flashes per second, it seems that the thunderstorm static from the earth at the distance of Jupiter would amount to about 5×10^{-21} W. m.$^{-2}$ (c./s.)$^{-1}$, which would be readily detectable by contemporary techniques such as that used by the Carnegie workers. However, this signal would appear as a steady background, whereas the Jupiter signals occurred on only one day in three and were apparently in the form of bursts. It seems clear that the further development of this work may well provide new and valuable information about the conditions in the atmosphere of Jupiter.

ABNORMAL PROTEIN ASSOCIATED WITH TOBACCO MOSAIC VIRUS

Structure of Polymerized Tobacco Plant Protein and Tobacco Mosaic Virus

WHEN tobacco plants are infected with tobacco mosaic virus, an abnormal protein can be isolated from the tobacco leaves[1]. It has been demonstrated that this protein is non-infectious, is free of ribonucleic acid, and is immunologically related to the protein component of the virus. In addition, this protein has the peculiar property of polymerizing into rod-like structures when brought close to its isoelectric point at *p*H 3·8. In the electron microscope, these rods appear to be similar to tobacco mosaic virus rods, except that their length is more variable than that of freshly harvested tobacco mosaic virus.

There has been some debate concerning the exact nature of these nucleic acid-free rods, which appear so similar to tobacco mosaic virus[2,3]. A recent amino-acid analysis has shown that the composition of the abnormal protein is virtually identical to that of the protein component of the virus[4]. Here we wish to present X-ray diffraction evidence which demonstrates that the internal structure of the nucleic acid-free particles is similar to that of the virus.

Samples of the abnormal protein from tobacco plants were prepared by methods which have been described previously[2]. Freedom from contamination with tobacco mosaic virus was assured by the following tests: (*a*) When the abnormal protein is prepared in unpolymerized form at *p*H 7, there is no high-molecular weight component observable in the ultra-centrifuge, and no evidence of a rapidly migrating component in electrophoresis. (*b*) The ultra-violet absorption spectrum is that of a protein free of nucleic acid, with the ratio of optical densities at 280 mμ and 260 mμ of 1·6–1·7; for tobacco mosaic virus this ratio is 0·83. (*c*) Electron micrographs of unpolymerized abnormal protein show no tobacco mosaic virus-like rods. (*d*) The material is not infectious. In summary, the contamination of abnormal protein by tobacco mosaic virus, if any, should be considerably less than 1 per cent.

The abnormal protein was gradually brought to its isoelectric point, and typical rod-like forms were observed in the electron microscope. Oriented air-dried films of this material and of tobacco mosaic virus grown on the same tobacco plants were prepared by the microscope slide technique of Bernal

and Fankuchen[5]. The observed birefringence of the films was + 0·003, as reported previously for tobacco mosaic virus, and − 0·002 for the abnormal protein. X-ray diffraction photographs were taken with copper $K\alpha$ radiation in a 10-cm. cylindrical camera filled with helium.

Tobacco mosaic virus has been extensively studied by X-ray diffraction methods. Bernal and Fankuchen[5] have shown that the rods are arranged in hexagonal close packing, with interparticle distances which can be varied with the amount of water present. Only the equatorial reflexions arise from the hexagonal lattice. The non-equatorial scattering is relatively unaffected by changes in water content. It represents the continuous transform of a single particle and, as such, is characteristic of the internal structure of the virus. Watson[6] has proposed a helical arrangement of the protein sub-units in the virus particle. A recent paper by Franklin[7] has demonstrated with remarkable detail the finer features of the tobacco mosaic virus diffraction pattern.

Although the orientation of the abnormal protein in the air-dried films was not as complete as in the films of tobacco mosaic virus, the general similarity of the two diffraction patterns is very obvious. The 3rd and 6th layer lines are very intense and close to the meridian, the 9th is weaker; the 2nd and 7th layer lines show strong off-meridional reflexions. All these features are characteristic of the tobacco mosaic virus diffraction pattern and establish the gross similarity of the structures.

Measurements on the equator of the photographs of the abnormal protein are obscured by poor orientation and are not reliable. However, it is apparent from our photographs that significant differences in the diffraction pattern occur in this region. Table 1 lists the spacings observed, together with their intensities and hexagonal indices. Bernal and Fankuchen[5] have pointed out that the intensities are very sensitive to water content. In these experiments, both samples were treated identically. The correspondences between the patterns indicate that the hexagonal arrangement of the tobacco mosaic virus rods is retained in the abnormal proteins with little change in spacing, possibly a slight increase. The most striking difference is the absence of the strong 50-A. reflexion in the abnormal protein photographs.

Table 1. Comparison of Equatorial Reflexions

h^2+k^2+hk	Tobacco mosaic virus d (A.) observed	Abnormal protein d (A.) observed
1	(not observable in this apparatus)	
3	74 (vvs)	77 (vvs)
4	—	(67 (vvw) ?)
7	50 (vs)	—
12 (13)	36 (m)	37 (m)

Intensities: vvs = very, very strong; vs = very strong; m = medium; vvw = very, very weak.

The equatorial scattering from tobacco mosaic virus has already been shown to follow approximately that expected from an array of cylindrical rods of diameter about 150 A. and of uniform scattering density[6]. We do not believe that the equatorial scattering of the abnormal protein can be adequately interpreted in this way. We can, however, account for it as follows.

We regard the abnormal protein not as a uniform structureless rod, but rather as a cylindrical shell of protein surrounding an empty (water-filled) core. The Fourier transform of such a shell is the difference of two first-order Bessel functions:

$$T(h) = R^2 \frac{J_1(2\pi hR)}{2\pi hR} - r^2 \frac{J_1(2\pi hr)}{2\pi hr}$$

where R is the external radius, r is the internal radius corresponding roughly to the radius of the ribonucleic acid core of tobacco mosaic virus, and h is distance in reciprocal space. If R is taken as 76 A., the protein shell being supposed identical with that of tobacco mosaic virus, the transform becomes zero at 50 A.$^{-1}$ for r = 19·5 A. This radius for a ribonucleic acid core corresponds to a value of 6·6 per cent ribonucleic acid in tobacco mosaic virus, assuming, as we have above, that cross-sectional area is proportional to mass. The experimentally observed value is near 6 per cent[8]. The calculated percentage is, of course, sensitive to the assumed diameter of the protein rod.

A central location for viral nucleic acids has been discussed previously. Watson[6] has considered such a model for tobacco mosaic virus itself. The deoxyribonucleic acid in the bacteriophage virus T_2 is believed to be located inside the virus[9]. A similar interpretation has been given for turnip yellow virus. The low-angle X-ray studies of Schmidt, Kaesberg and Beeman[10] indicate that the ribonucleic acid-free virus particles have an inner sphere of low density, a region in which they believe the ribonucleic acid is replaced by water.

Careful measurements of the c-axis spacing produced by the abnormal protein showed a shortening of 5 per cent less than the usual value of 68 A., or about 3·5 A. shorter. One possibility is that the absence of the ribonucleic acid permits the protein units to pack more tightly, perhaps eliminating one layer of water molecules. In this regard, Franklin[7] points out that there is an important structural discontinuity between the various turns of the helix, possibly associated with an external grooving. It may be that this groove is partially eliminated in the absence of the ribonucleic acid.

In summary, these studies have pointed out the essential similarity between the configuration of the polymerized abnormal protein of the infected tobacco plant and the virus itself. Small differences are observed in the diffraction patterns, which suggest that it may be possible to determine accurately the position of the ribonucleic acid in the virus.

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X-Ray Diffraction by an Abnormal Protein (*B8*) associated with Tobacco Mosaic Virus

From extracts of plants infected with tobacco mosaic virus, proteins related to the virus but not associated with ribonucleic acid have been isolated independently in three laboratories[1–5]. These abnormal non-virus proteins are immunochemically related to tobacco mosaic virus, and have the property of polymerizing to rod-shaped particles similar to those of tobacco mosaic virus. X-ray diffraction studies of one such preparation of polymerized non-virus protein have been reported by Rich, Dunitz and Newmark in the preceding communication (we are much indebted to these authors for sending us their manuscript before publication). The present communication describes some preliminary X-ray diffraction measurements on a preparation of the polymerized non-virus protein which Commoner[2] has designated *B8*.

The observations reported here differ in some respects from those of Rich, Dunitz and Newmark. We shall therefore first consider how our *B8* preparation may differ from their 'abnormal protein'.

Takahashi[4] reported two abnormal non-virus proteins designated 'X' and 'short particles' respectively. Commoner *et al.*[2,6] described three abnormal non-virus proteins, *A4*, *B3* and *B6*. The most recent results reported by Jeener *et al.*[5] indicate the presence of two abnormal components. Each of the above low-molecular weight unpolymerized components is capable of polymerizing to form a high-molecular weight rod.

Comparison of the electrophoretic patterns of Takahashi and of Jeener with those of Commoner indicates that: (*a*) component *B6*, which polymerizes to form *B7*, is equivalent to Takahashi's 'short particles' and to Jeener's more rapid component; (*b*) component *B3*, which polymerizes to form *B8*, is equivalent to Takahashi's 'X' and to Jeener's slower component. The *B8* used in the present investigation should thus be equivalent to Takahashi's 'polymerized protein X'.

Recently, however, Delwiche *et al.*[7], and Rich *et al.*, have found only a single abnormal non-virus protein, to which they refer as "the abnormal protein". Recent investigations by one of us (B. C.) indicate a possible source of this discrepancy. It has been found that solutions containing mixtures of components *B3* and *B6* will, upon standing in the cold, co-polymerize to form a single high-molecular weight component which is very similar to *B8*. Examination of the process employed by Delwiche *et al.* to prepare their 'abnormal protein' suggests that their preparations may contain such a co-polymer of *B3* and *B6* rather than pure *B8*.

It is therefore possible that minor differences between the X-ray diffraction patterns of *B8* and of the 'abnormal protein' of Rich *et al.* may be due to minor differences of constitution, of the type here described. We think it unlikely, however, that there is any major structural difference between the two preparations.

The *B8* protein used in the present investigation was prepared in the form of a highly purified solution of concentration about 0·3 per cent and preserved in a dialysis sack suspended in distilled water. The volume was afterwards reduced between 50- and 100-fold by allowing water to evaporate slowly through the dialysis sack. The resulting concentrate contained fibrous regions of gel showing weak positive birefringence, suspended in non-birefringent liquid. When this suspension is introduced into a glass capillary tube, the regions of fibrous gel align themselves approximately parallel to the axis of the tube. X-ray photographs of the gel were obtained from material orientated in this way.

Dry orientated specimens were obtained by drying the gel suspension through a meniscus between two glass plates, according to the method of Bernal and Fankuchen[8]. It was found that, as water was removed from the gel, the birefringence decreased, passed through zero, and finally became negative. The dry *B8* has a negative birefringence approximately equal in magnitude to the positive birefringence of dry tobacco mosaic virus.

X-ray fibre diagrams of dry *B8*, of *B8* dried and afterwards humidified by maintaining in an atmosphere of 75 per cent relative humidity, and of *B8* gel, are compared, in Figs. 1, 2 and 3 respectively, with the X-ray fibre-diagram of a tobacco mosaic virus gel. A high-resolution photograph of the central region of Fig. 1 (dry *B8*) has also been obtained, and shows a series of equatorial reflexions corresponding to a close-packed assembly of rods of diameter 150 A. The intensities of these reflexions agree fairly well with those reported by Rich *et al.*, except that a reflexion at 65 A. is sharp and of medium strength, and one at 49 A. is weak but clearly visible.

The resemblance between the X-ray photographs of *B8* and those of tobacco mosaic virus may perhaps appear rather slender. However, the strong similarity between *B8* and tobacco mosaic virus protein in other respects (immunochemical cross-reactions, size of the basic chemical unit, and diameter of the rod-shaped particles) makes it very probable that a close structural relationship exists. It therefore seems justified to relate the prominent meridional maxima of the *B8* diagrams to the near-meridional regions of high intensity in tobacco mosaic virus. (The less good orientation in the *B8* diagrams makes it impossible to say whether or not the maxima are truly meridional.)

The most striking feature of the diagrams shown in Figs. 1, 2 and 3 is that the fibre-axis spacings given by the prominent meridional maxima in *B8* vary by more than 20 per cent with changing water content. In tobacco mosaic virus the axial spacings are the same whether the virus be dry, moist, or in the gel state.

X-ray diffraction studies[9,10] on tobacco mosaic virus have shown that the protein is in the form of units, of molecular weight probably about 30,000, set in helical array around the axis of the virus rod. The pitch of the helix is 23 A., the fibre-axis repeat period of 69 A. containing three turns of the helix. The strongest near-meridional diffraction in tobacco mosaic virus occurs on the 3rd and 6th layer-lines, corresponding to the first and second orders of the pitch of the helix.

The two principal meridional maxima of the dry *B8* occur at slightly larger angles than those of tobacco mosaic virus, and indicate axial spacings about 6 per cent smaller than the tobacco mosaic virus spacings (Fig. 1). However, when water is added to *B8*, these maxima move towards the centre of the diagram. In the gel state the corresponding spacings are about 15 per cent larger than in tobacco mosaic virus (Fig. 3).

These results suggest that *B8* protein forms a structure grossly similar to that of tobacco mosaic

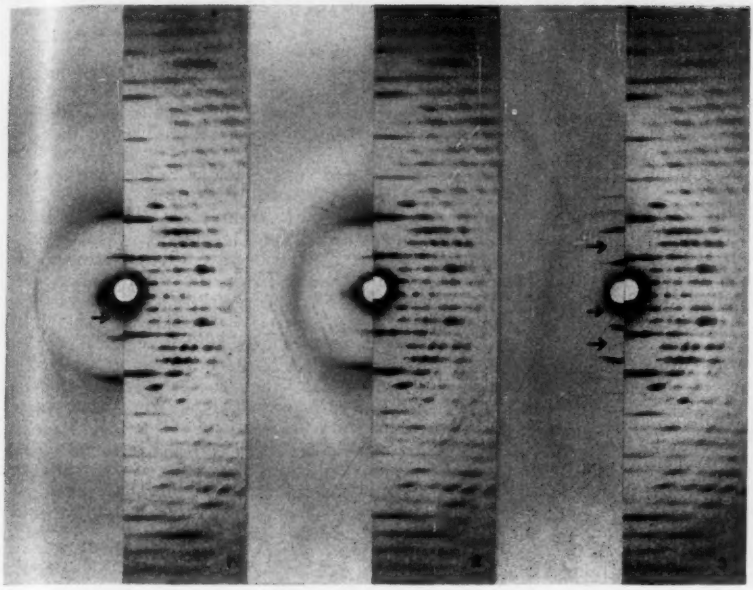

Fig. 1 Fig. 2 Fig. 3

X-Ray fibre diagrams of protein *B*8 (left-hand side of each figure) compared with fibre-diagrams of orientated tobacco mosaic virus gel.

(1) *B*8 dry. (2) *B*8 previously dried, then maintained at 75 per cent relative humidity. (3) *B*8 orientated gel.

Arrows in photographs indicate positions of meridional or near-meridional maxima on 1st and 3rd layer-lines of *B*8

virus protein, but more loosely held together. In tobacco mosaic virus, X-ray diffraction studies[10] have led to the conclusion that there is a marked structural discontinuity at the geometrical interface between one turn of the helix and the next. It is probable that there is no specific chemical bonding across this interface. (Further evidence of this has recently been obtained by one of us (R. E. F.) and will be published shortly.) Successive units along the tobacco mosaic virus helix, on the other hand, appear to be strongly linked, and it is this linking which is probably similar to that which occurs when *B*3 polymerizes to form *B*8. In tobacco mosaic virus the resultant helical structure is highly regular and rigid. In *B*8, due partly, perhaps, to the absence of ribonucleic acid, the polymerized protein can expand and shrink with changing conditions.

Two possible mechanisms for the change in length of *B*8 can be suggested. If the polymerization of *B*3 to *B*8 produced a helical structure like that of tobacco mosaic virus protein, then the changes of length in such a structure might be supposed to take place in a manner analogous to the stretching and retraction of a coiled spring. One important feature of the X-ray diagrams of *B*8 is, however, difficult to reconcile with this picture. Whereas in tobacco mosaic virus, and also in the abnormal protein of Rich, Dunitz and Newmark, the principal near-meridional maxima occur on the 3rd and 6th layer-lines, in *B*8 the layer-lines on which the corresponding maxima lie are the 2nd and 4th. Weak but distinct meridional or near-meridional maxima occur on the 1st, 3rd and 5th layer-lines of *B*8. The positions of the strongest of these are indicated by arrows in Figs. 1 and 3. It is the presence of these maxima which is apparently inconsistent with the existence in *B*8 of a helical structure similar to that of tobacco mosaic virus.

Since the tobacco mosaic virus helix is a rather flat one, a quite small geometrical distortion could lead to the formation of a cyclic rather than a helical polymer from the same protein building units. The resulting flat, cyclic polymer units might then stack one above the other to form a rod the structure of which is grossly similar to that of tobacco mosaic virus protein. If the formation of *B*8 from *B*3 occurs by such a mechanism, then the near-meridional maxima on the 1st, 3rd and 5th layer-lines could be explained provided that the cyclic units were somehow associated in pairs when stacked. The change in length of the polymer rod with changing water content would then be due to the penetration of up to two monolayers of water between neighbouring cyclic polymer units.

If we are right in thinking that the structure of *B*8 is closely related to that of tobacco mosaic virus protein, then considerable importance must be attached to the reversal of the sign of birefringence in *B*8. We must conclude that the ribonucleic acid makes a positive contribution to the birefringence of tobacco mosaic virus, and hence that the purine and pyrimidine rings are aligned approximately parallel to the axis of the particle. If the ribonucleic acid in tobacco mosaic virus forms a central core (see Rich *et al.* and ref. 9), it follows that its structure must differ considerably from the structure of deoxyribonucleic acid described by Crick and Watson[11].

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LETTERS TO THE EDITORS

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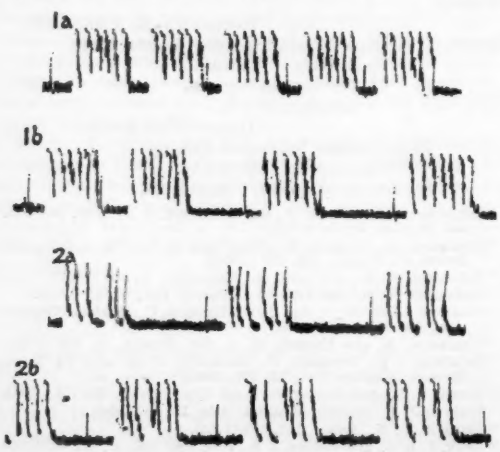
Effect of Delayed Acoustic Feed-back on some Non-vocal Activities

It is well known that difficulties in speaking will result if the speaker is made to listen to the sound of his own voice delayed by about 0·1–0·3 sec. This delayed feed-back will produce stuttering, reduced rate of speaking, distortion of sound quality and other impairments of speech[1].

It was thought interesting to find out how far delayed acoustic feed-back would affect non-vocal activities which one might expect to be controlled more by other means, for example, by proprioception or the sense of touch. Exploratory experiments showed that whistling and the playing of musical instruments were, in fact, strongly influenced by delayed acoustic feed-back, and even such comparatively simple activities as rhythmical hand clapping were disorganized. Results of some experiments of the last type are given below.

In the experiment, any sound produced by the subject was recorded and played back through headphones either immediately or with a delay of about 0·25 sec. Whereas acoustic feed-back was thus controlled, all other sensations such as touch or proprioception connected with the clapping of hands reached the subject without artificial delay. There was also an electronic metronome that produced short timing clicks in his ear at 2-sec. intervals; this was never delayed. The sound of the handclaps and the metronomic beats were recorded on a second tape recorder in the normal way for later analysis. A pen recorder was used for obtaining from the second record traces of the type shown in Fig. 1. The claps appear as clearly distinguishable deflexions of the pen, and the metronome clicks are indicated by short sharp spikes.

The subject's first task consisted in clapping his hands as regularly as possible six times following each metronome click. Fig. 1*a* shows that this was accomplished quite easily when there was no acoustic delay; when a 0·25 sec. delay was introduced (Fig. 1*b*), hands were often clapped seven times instead of six times, and at other times clapping ceased altogether after alternate clicks.



The second task consisted in clapping two groups of three beats after each metronome click with a strong accent on the first clap in each group. Playing back without delay again did not disrupt the performance (Fig. 2*a*); but delay of 0·25 sec. almost invariably resulted in four claps being produced in the second group instead of three (Fig. 2*b*). It should be mentioned that the subjects were sometimes aware of their mistakes and tried more or less successfully to overcome them, usually by concentrating on the task and slowing down the performance. In other cases, however, people were unaware of their mistakes.

These short preliminary experiments show that acoustic feed-back plays an important part in the performance of tasks which one would have thought to be controlled more by reafference from other senses. It seems that every hearing person is subject to these effects to some degree; but the response varies a great deal between people, and the study of this variation promises some insight into individual development and possibly into the genetics of certain faculties concerned with rhythm and counting.

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Improved Resolution with the X-Ray Projection Microscope

A resolution of 0·1μ (1000 A.) has now been reached with the shadow type of X-ray microscope by using a thin gold-leaf X-ray target. The instrument described previously by Cosslett and Nixon[1–4] was limited to a resolution of 0·5μ due to astigmatism in the electron lens and to electron scattering in the metal target. An attempt was made to reduce the astigmatism by stopping down the aperture of the objective lens used for focusing the electrons. No improvement in resolution was found even for a semi-angular aperture of 2×10^{-3} rad. giving an astigmatic disk of confusion of 0·2μ for the worst possible machining errors of the pole pieces. This indicated that electron scattering in the metal foil target was the true limit on resolution.

An electron-range of 0·2μ in gold at 10 kV. is found from the Thomson–Whiddington law[5], and the scattering angles can be very large at this low voltage. In this way the X-rays used for shadow microscopy could have been produced anywhere in a hemisphere of radius 0·2μ, in good agreement with the previous resolution. Recently, Ehrenberg and Franks[6] have shown that the electron-range is even greater than this in transparent phosphors at this kilovoltage. It might be thought that the effect of electron-scattering in the target could be reduced considerably by evaporating a layer of heavy metal, such as gold or tungsten, on to a thicker beryllium foil to provide

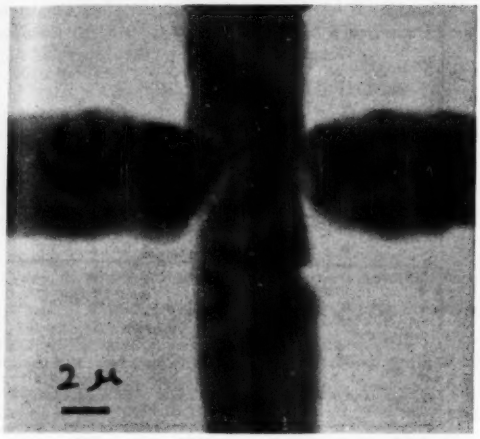

Fig. 1. Contamination of a 1,500 mesh/in. test grid by electron bombardment at atmospheric pressure. X-ray micrograph, using 0·1μ gold-leaf X-ray target. (× 3,600.) 5-min. exposure, 10 kV.

mechanical support. This type of X-ray microscope target has been suggested[7,8] and used[9,10]; but no improvement in resolution was found. If the metal layer is less than half the penetration-range, and this is not exactly known in view of Ehrenberg and Franks's work[6], then 5 per cent of the X-rays generated will come from a region of the beryllium of diameter 2μ and will spoil the improved resolution. Evaporated layers much less than the penetration-range would be chosen to give a large improvement, and in this case a much greater percentage of X-rays would come from the beryllium. In fact, reasonable X-ray micrographs of a 1,500 mesh/inch silver grid with a resolution of 2μ and a 5-min. exposure at 10 kV. have been obtained from beryllium only, with no heavy-metal layer.

An X-ray target of beaten gold leaf, 0·1μ thick, stretched over a 100μ aperture, has been used for reaching a resolving power of 0·1μ for the X-ray shadow projection microscope. Such a foil target supports atmospheric pressure without being so porous as to leak unduly, and does not break for high electron current densities if the spot is less than 1μ. Many electrons penetrate the foil and strike the specimen (50μ beyond), causing electron-induced contamination as in the electron microscope. A test grid is shown in Fig. 1 at 3,600 ×, demonstrating the 'padding' of the grid bars by contamination and demonstrating the new resolution. The rate of formation, 2 A./sec. or 0·7μ/hr., is similar to that found in the electron microscope[11], although this contamination occurs at atmospheric pressure and without pump oil vapour present. This result seems to favour the condensation theory of Ennos[11] or even a return to the ionization postulate of Watson[12]; further work on contamination by this new method is being carried out.

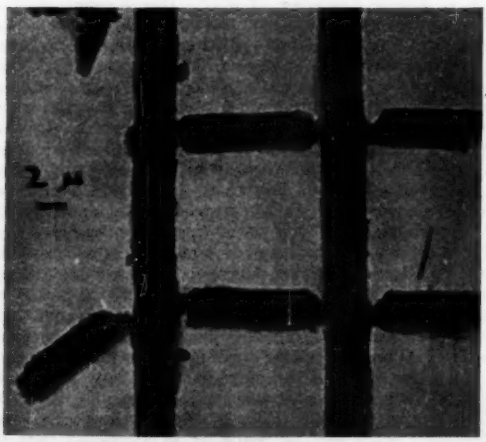

Fig. 2. X-ray micrograph of a 1,500 mesh/in. test grid (uncontaminated), showing Fresnel edge diffraction fringes of width 0·1μ. (× 2,000.) 5-min. exposure, 10 kV.

With this improved resolution Fresnel edge diffraction fringes of 0·1μ width are seen when the specimen and photographic plate are correctly placed. A test grid with such a fringe is seen in Fig. 2 at 2,000 ×. It is suggested that the minimum first fringe width of this edge diffraction pattern be used as a resolving-power test for all X-ray microscopes. Specimen and plate distances could in principle be adjusted to record a fringe equal to a resolving power even as good as 100 A.

The unexplored region beyond the ultra-violet microscope, with the specimen at atmospheric pressure, will become accessible if the resolution can be improved still further. To do this it will be necessary to use even thinner gold-foil targets, voltages in the 2–5 kV. region to reduce electron penetration and increase contrast, and possibly some astigmatism correction of the magnetic or electrostatic lens used.

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An Alternative Identification of the Radio Source in the Direction of the Galactic Centre

A RADIO source the co-ordinates of which agree closely with those of the centre of the Galaxy has been reported by several observers, and it has been suggested that it may be identified with the nucleus of the Galaxy[1–3]. The galactic co-ordinates of this source are $l = 327°$ and $b = -2°$, and it is designated 1752*A* in the list recently published by the International Astronomical Union[4]. The apparent angular diameter of the source has been observed by Mills[5] to lie between ½° and 1° at 100 Mc./s. An independent estimate made at Jodrell Bank at 1,420 Mc./s. indicates that the diameter is 1°.

If the identification of this source with the nucleus of the Galaxy is accepted, then at a distance of 8 k.parsecs the diameter of the nucleus would be about 150 parsecs, which is small compared with that of the nucleus of a typical spiral nebula similar to our Galaxy. Furthermore, a careful study of the radio isophotes in the direction of the galactic centre shows that this source is displaced considerably ($\sim \frac{3}{4}°$) from the centre of symmetry of the isophotes, suggesting that it does not lie in the centre of the system.

In view of these doubts about the identification of the radio source with the galactic nucleus, an attempt has been made to determine its distance by means of the absorption by interstellar hydrogen at 1,420 Mc./s. The measurements have been carried out by two methods.

The first method is analogous to that used in optical astronomy for measuring the distance of stars by means of the equivalent width of interstellar absorption lines[6]. A detailed study has been made of the hydrogen line spectrum in the region of the galactic centre, and the absorption spectrum of the source has been found. The equivalent width of the absorption line is 65 kc./s. A study by us (unpublished) of the radio sources in Cassiopeia, Cygnus and Taurus indicates that there is a linear relationship between the equivalent width of the absorption line and the extent of the Galaxy between the observer and the source. These results suggest that a line-width of 65 kc./s. corresponds to a distance of 2·9 k.parsecs.

The second method[7] depends upon a measurement of the absorption of the source at the centre frequency of the hydrogen line emission spectrum. Fig. 1*a* shows the drift curve taken across the source in continuous emission (away from the hydrogen line). Fig. 1*b* shows drift curves taken with the double-comparison spectrometer at the hydrogen-line frequency. The full line is taken across the source and the dotted line is taken at a point closely adjacent to the source. These observations show that 36 per cent of the radiation from the source is absorbed at the hydrogen-line frequency. An estimate of the distance of the source can be made if the distribution of hydrogen and its kinetic temperature is known in the line of sight of the source. Taking the kinetic temperature of the hydrogen to be 100° K., and estimating the distribution of the hydrogen from the available surveys of the Galaxy[8], it can be shown that the observed absorption of 36 per cent will be reached in a distance of about 2·7 k.parsecs.

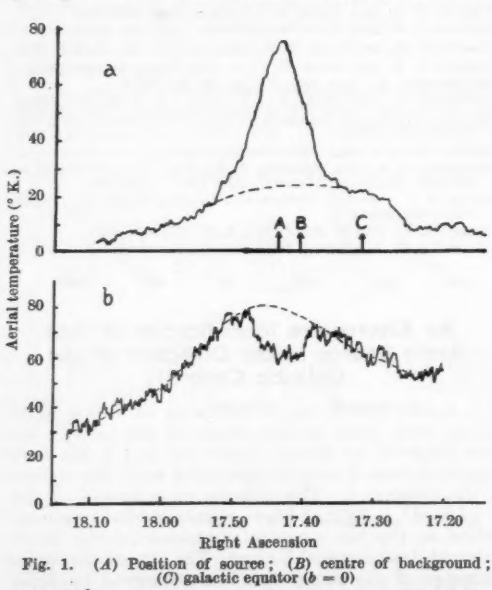

Fig. 1. (*A*) Position of source; (*B*) centre of background; (*C*) galactic equator ($b = 0$)

(*a*) Drift curve taken across the source in continuous emission. (*b*) Drift curves using the double comparison receiver at the hydrogen line frequency. The full line is taken across the source, and the dotted line is taken at a declination 2° from the source

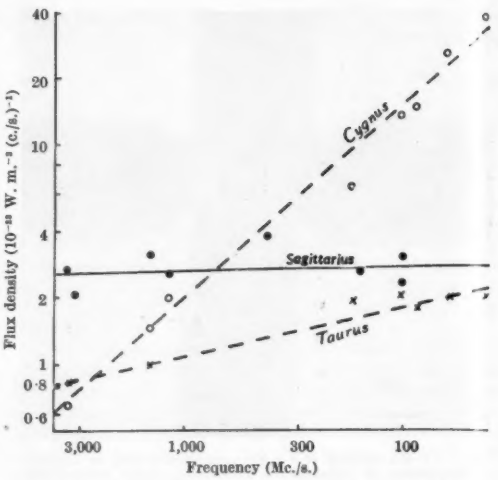

Fig. 2. Spectrum of the Sagittarius source (full line). The spectra of the Cygnus and Taurus sources (dotted lines) are shown for comparison

Although both these methods of measuring distances are subject to considerable errors, they are largely independent and they indicate strongly that the distance of the source is considerably less than that of the galactic centre (8·2 k.parsecs).

The spectrum of the source shown in Fig. 2 has been obtained from the published data[1,3,9] (the intensities given in refs. 9*a* and *b* have been corrected for a source diameter of 1°). The spectra of the well-known sources in Cygnus (19*N*4*A*) and Taurus (05*N*2*A*) are shown for comparison. It can be seen that the spectrum is flat, which suggests that the emission is taking place in a region of optically thin gas. Taking a distance of 3 k.parsecs, the diameter of the source (about 1°), indicates that the extent of this region is about 50 parsecs. This evidence suggests that the radiation is taking place, not from the galactic nucleus but from an ionized region of gas situated at about 3 k.parsecs. An aggregate of thirty-eight early-type stars has been reported by Hiltner[10] at a distance of 3 k.parsecs in a direction which corresponds precisely to that of the radio source. It is possible that this group of hot stars is associated with a nebulosity which, in the same way as the Orion and Trifid nebulae, gives rise to a radio source. There is heavy obscuration in this direction of the Galaxy, and therefore it is unlikely that such a nebulosity would be observed optically. Although no positive identification of the source with this group of stars can be made, it is suggested that it represents a more likely origin for the radiation than the galactic nucleus.

We wish to thank Prof. A. C. B. Lovell, the director of this Station, and Mr. R. Hanbury Brown, for their interest in this investigation.

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Effect of Density Differences on the Path of Jets

In the application of model techniques to furnace design, a problem which has long resisted solution is the simulation of the buoyancy effect of hot flames rising within the cooler furnace atmosphere. An attempt is being made to solve this problem by the use of a water model.

The technique involves the use of a jet of magnetite slurry, which represents the flame jet, and water, which represents the combustion air. The jet of magnetite, being heavier than the surrounding water, sinks, and so provides an 'upside-down' picture of the rising flame-jet. A 'Perspex' box with dimensions 2·5 ft. × 2 ft. × 1 ft. represents the combustion chamber, into which water is pumped from a settling tank through a filter. The slurry is injected from a mixing drum, which is kept under pressure by a small blower. The discharge from the model returns to the settling tank, the water being recirculated.

During the development of this technique, it was found that the distribution of the jet did not agree with that predicted by the established formulæ. The formula suggested by Groume-Grijmailo[1] for the path of an infinitely thin jet is not justifiable, because it contains the assumption that the horizontal velocity is constant, which is far from the truth. Davis[2] developed an expression to include the effect of this decreasing velocity due to entrainment. However, the displacement of the jet in a vertical direction according to Davis's formula is based on Newton's second law of motion assuming constant density of jet fluid. This again is incorrect because the density changes, also due to entrainment, until it approaches that of the surrounding fluid. If constant density is assumed, the vertical displacement is grossly exaggerated.

In the light of these observations, an expression was developed for the path of a free jet to include both the effect of varying velocity and varying density. If considerations are restricted to the axis of the jet and to distances not less than 13 diameters from the nozzle, the vertical displacement of the axis of a horizontally fired jet from a circular nozzle is given approximately by:

$$\frac{y}{D} = \frac{64\,g s K_{11}^2 D}{U_0^2 A^2}\left[\frac{\sqrt{A}}{3}\left(\frac{x}{D}\right)^3 - \frac{S}{2}\left(\frac{x}{D}\right)^2 + B\frac{x}{D}\left(\frac{x}{2D} - \frac{S}{\sqrt{A}}\right)\log_e\frac{x}{D}\right]$$

where y is displacement in vertical direction; x is displacement in horizontal direction; g is the acceleration due to gravity; U_0 is the jet velocity at the nozzle; D is the nozzle diameter; S is $(\rho_0 - \rho_s)/\rho_s$, ρ_0 being density of jet fluid and ρ_s density of surrounding fluid; B is $\left(\frac{\rho_0 - \rho}{\rho_s}\right)\frac{K_{21}}{K_{20}}$; A is $8\frac{\rho_0}{\rho_s}\frac{K_{11}^2}{K_{20}}$; K_{11} is $\frac{1}{2k(\mu+1)}$; K_{20} is $1/4k$; K_{21} is $\frac{1}{2k(\mu+2)}$.

K_{11}, K_{20}, K_{21} arise from the integration of error functions to which the concentration[4] and velocity profiles[2] in the jet are assumed to conform. k,μ are constants deduced by extrapolation of the values experimentally determined by Keagy and Weller[5] to $\rho_0/\rho_s = 2$.

Fig. 1 is a photograph of a magnetite jet issuing from a nozzle of 0·125 in. diameter. The predicted path is shown by the dotted line within the jet. A comparison of predicted and actual values is shown below, the axis of the jet being assumed to be placed symmetrically within the jet boundaries.

x/D	y/D	y/D predicted by equation	y/D predicted by Davis
24	0	0·2	28·4
48	3·6	2·7	227·2
72	11·8	10·1	
96	28·6	25·2	
120	47·2	50·6	
144	77·0	88·6	

A technique is being developed for analysing the jet quantitatively, and it is hoped that this will

Fig. 1

furnish further information concerning the influence of density differences on the path of jets.

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Fluorescent Centres in Uranium-activated Sodium Fluoride

The sodium fluoride fusion method is commonly used for the determination of minute amounts of uranium[1]. The sample to be tested is fused in a platinum crucible with sodium fluoride, and the fluorescence is measured in a fluorimeter. By this method, amounts of uranium down to 10^{-10} gm. can be determined in 0·2 gm. of fluoride.

Sodium fluoride containing uranium has a bright yellow-green fluorescence when excited by long-wave ultra-violet radiation. Even at room temperature the emission consists of broad bands partially resolved into lines, and at 77° K. the spectrum consists of more than twenty lines (see Fig. 1). This emission has been described by Slattery[2], who concluded that the uranium is in solid solution with the fluoride. The fluorescence would then be attributed to a UF_6 group. Solid UF_6, however, has a bright violet fluorescence bearing little resemblance to the sodium fluoride (uranium) emission.

Another possibility which has been considered in the past is that the fluorescence belongs to a uranyl group. The fluorescence exhibits the right colour, but does not show the characteristic unresolved bands at room temperature or the repetition frequency of about 860 cm.$^{-1}$.

A consideration of the principle of localized charge compensation[3] has suggested another solution to this problem. Supposing a uranium ion in the hexavalent state replaces a sodium ion, then there will be an excess of five units of charge. This can be compensated either by positive ion vacancies or by divalent negative ions. As the samples are melted in air, and since the uranium is often present as a uranyl group, it is quite probable that charge compensation can occur by the entry of oxygen ions, five being necessary to give perfect compensation. The relative simplicity of the emission spectrum indicates a highly symmetrical arrangement, and in view of the known stability of octahedral UO_6 groups in alkaline-earth oxide[3] and uranate[4] phosphors, it is concluded that the six fluorines surrounding the uranium ion are replaced by oxygens. This hypothesis explains both the colour of the emission, which is characteristic of U—O bonding, and the repetition frequency of about 740 cm.$^{-1}$ characteristic of the UO_6 group[3].

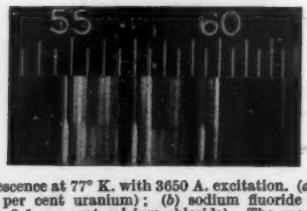

Fig. 1. Fluorescence at 77° K. with 3650 A. excitation. (*a*) sodium fluoride (0·1 per cent uranium); (*b*) sodium fluoride (0·1 per cent uranium, 0·1 per cent calcium chloride). The spectra were obtained on an Astra III plate using a medium quartz spectrograph

The centre has now a net charge of minus one and can attract ions with an excess positive charge. In particular, a divalent ion in the nearest positive ion site will cause complete charge neutrality. This is especially significant, as it has been shown[5] that small quantities of divalent ions, for example, calcium or magnesium, can cause an anomalous enhancement of the fluorescence of uranium in alkali-metal carbonate fluxes containing sodium fluoride.

In the present investigation it has been found that there is a marked change in the line intensities of the spectra, when calcium, in this case as chloride, is added to sodium fluoride (uranium) (see Fig. 1). This occurs when the atomic percentage of both the uranium and calcium is less than 0·1; and it is difficult to see how the relative intensities of the principal lines can change, as shown, unless pairing of the uranium and calcium ions occurs.

This conclusion is in disagreement with that of previous authors[6], who based their argument on the observation that the percentage quenching of an impurity is independent of the concentration of uranium. This independence has not been fully verified by other workers[7], although the variation with uranium concentration is not great.

It is hoped to extend these preliminary observations and to publish a fuller account at a later date.

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A Method of measuring Stress in Dentures

The high incidence of midline fracture in polymethyl methacrylate full upper dentures has prompted an investigation as to its cause.

During the course of the work, a simple technique for the analysis of the stress distribution over the surface of a denture has been developed. The method adopted uses a brittle lacquer ('Strainlac', manufactured by R. D. Walker, Vine Cottage, Corbridge, Northumberland) which has found industrial application as a tool of experimental stress analysis. Briefly, the technique is as follows. The lacquer is sprayed on to the outer surface of the denture and allowed to dry. The coating is 0·003–0·007 in. thick. The denture is then stressed in the mouth and cracks appear in the lacquer wherever the tension stress exceeds a certain value defined by the strain-sensitivity of the lacquer. The cracks may be shown up more clearly by brushing a dye etchant on to the lacquer surface. Fig. 1, a photomacrograph of the

Fig. 1

region immediately behind the central incisors, shows an area of high stress, as indicated by a crowding of the crack lines. If a clear denture of polymethyl methacrylate is used, the cracks may be illuminated for photographic purposes, either by transmitted light (Fig. 1) or reflected light. Small areas of the main pattern may be photographed using reflected light, whereas larger areas may be photographed using transmitted light with slight loss of definition.

As yet, only qualitative analysis of the crack pattern on denture bases has been attempted until more information is available about the behaviour of the lacquer on plastic surfaces. Used qualitatively, however, the lacquer provides a quick method of indicating; (*a*) the points of high stress concentration; and (*b*) the direction of the principal stresses, since a crack runs perpendicular to the direction of the principal stress, which is a maximum and tensile. This information is sufficient to allow strain gauges to be placed on the surface at the most advantageous points. It also allows for the orientation of the gauges, one being placed in the direction of the major principal stress, the other at right-angles in the direction of the minor principal stress. From a knowledge of the strains in these two directions, together with the elastic constants of the material, the major and minor principal stresses may be computed.

Acknowledgments are due to Dr. J. H. Lamble, senior lecturer, Department of Mechanical Engineering, University of Manchester, for his assistance. This work is being carried out under the supervision of Prof. E. Matthews.

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The Amorphous Alloy

In 1920 Rosenhain, Haughton and Bingham[1] described a zinc/aluminium/copper alloy (89/7/4) the mechanical properties of which resembled those of an amorphous material, in that it was ductile at room temperature when deformed slowly but brittle when deformed quickly. A simple demonstration of this was that a piece of sheet made from the metal would bend double if bent slowly but snapped if bent quickly, just like an amorphous material such as pitch. It appears that no satisfactory explanation of this behaviour has been put forward that conforms with modern ideas.

Impact tests have been made on specimens of this alloy supplied by Mr. A. E. L. Tate, who demonstrated that, in sheet form, it behaved as described above. The impact tests were made in a Charpy machine on notched specimens (for convenience the notches were of the Izod type) over a range of temperatures from about − 200° C. to + 300° C.; for the tests above room temperature, specimens were immersed for 15 sec. in oil maintained at the desired temperature and then tested in about 4 sec. The results are shown in Fig. 1.

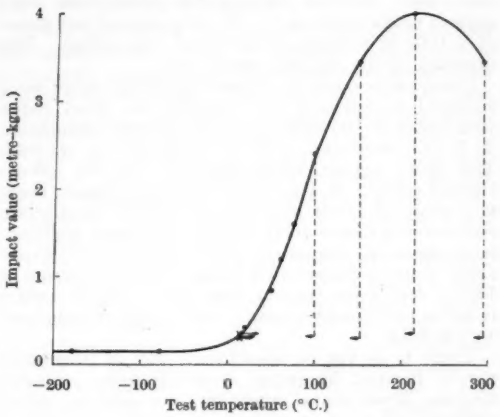

Fig. 1

The significant feature is the tough–brittle transition that takes place in the range + 200° to 0° C. To check that this was not due to a structural change brought about by warming, duplicate specimens were quenched into water at 13° C. from the different temperatures and quickly tested; the values so obtained are shown by crosses and clearly lie on the main curve, signifying that no structural change had taken place that affected the impact value. The alloy therefore shows a genuine tough–brittle transition.

A property of the tough–brittle transition phenomenon is that the temperature range of the transition depends on the speed of testing; it falls as the speed is decreased. The fact that this alloy shows a tough–brittle transition in the neighbourhood of room temperature then explains the behaviour described in the first paragraph: in a fast test such as rapid bending, the transition range is high and room temperature lies in the brittle region; in a slow test such as gradual bending, the transition range is lower and room temperature lies in a more ductile region.

The work described here has been carried out as part of the general research programme of the National Physical Laboratory, and this communication is published by permission of the Director of the Laboratory.

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Paper Electrophoresis of Reducing Agents

Continuing the study of trace substances in photographic gelatin[1,2], paper electrophoresis is being used for investigating the reducing agent present. The main interest is in the substance(s) which react immediately with iodine.

Fig. 1 (a photograph of the original electrogram) shows the separation of three anionic reducers, known or suspected to occur in gelatin. The apparatus used was as previously described; the paper was soaked in a *p*H 7 buffer prepared by mixing 2 lit. of 0·2 *M* disodium hydrogen phosphate with 500 ml. of 0·1 *M* citric acid. Sodium sulphite and thiosulphate were applied to the paper as 0·1 *M* solutions and reductone as a 0·05 *M* solution, neutralized with alkali. The duration of the run was two hours.

Compounds could be located as white spots on a coloured background by spraying the dried paper with either *N*/100 iodine or 0·025 per cent phenolindo 2 : 6 dichlorophenol, both in methanol or ethanol. The spots appear instantaneously on the iodine-treated paper. In the case of the dyed paper, there is a delay of about five minutes before the sulphite reacts and a longer delay with thiosulphate, although large spots are ultimately produced, since peripheral areas of low concentration react. The electrogram of Fig. 1 had been treated with dye. Silver nitrate is not a convenient reagent, as it is not decomposed by sulphite.

There is as yet no established way of presenting results derived by paper electrophoresis, probably because experimental conditions, for example paper texture, are hard to reproduce exactly. A kind of R_F value can be found by taking the ratio of the distance from the origin of any particular compound to that of a convenient reference compound, which may be thiosulphate in the present instance, in order to provide a link with the earlier results[2]. Even this characteristic, however, tends to fluctuate. Thus, in eight determinations, the R_F value (as defined) varied from 0·69 to 0·75 for sulphite and from 0·43 to 0·50 for reductone. The observed mobility of thiosulphate was of the same order as in the earlier experiments using a phthalate buffer. The actual distances moved by thiosulphate in two hours under a potential gradient of 5·2 V./cm. ranged from 9·2 to 11·7 cm. The mobility of

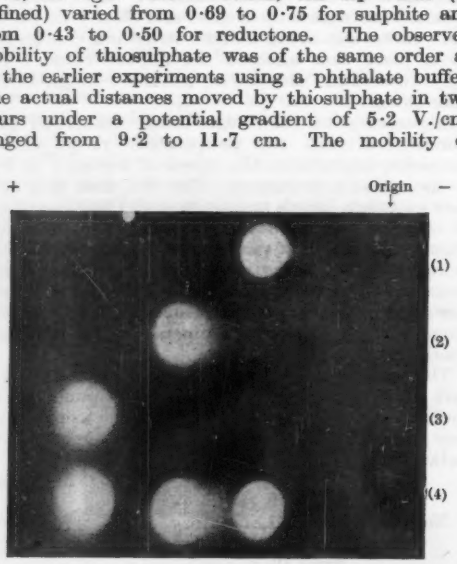

Fig. 1. Separation of anionic reducing agents: (1) reductone, (2) sulphite, (3) thiosulphate, and (4) mixture

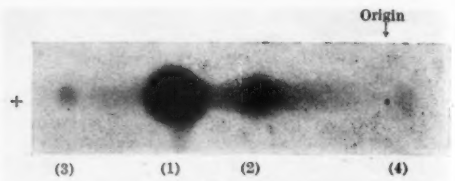

Fig. 2. Examination of aged reductone solution

the sulphite ion corresponds with that of pentathionate.

Other possible reducers can also be dealt with. Ascorbic acid and glutathione (taken as a model for a cysteine-containing polypeptide) both move towards the anode, but less rapidly than reductone, their R_F values, again relative to thiosulphate, being about 0·3 and 0·2, respectively. Cysteine moves very slightly towards the cathode; this is ascribed to the operation of an electro-osmotic effect. All three compounds reduce iodine and the dye reagent immediately. Ascorbic acid can be separated completely from reductone in a 2-hr. run. A feature of the result given by ascorbic acid is that a tail slowly develops to the main spot; this has been traced to decomposition of the compound on the paper. The differentiation of dienols such as reductone and ascorbic acid has previously been effected by Mapson and Partridge[3] using paper chromatography.

Reductone was prepared for the present experiments by the method of von Euler[4]. The purity of the recrystallized specimen was confirmed by the finding that it gave rise to a single spot only. Paper electrophoresis is likely to prove useful in the investigation of compounds related to, or derived from, reductone. Fig. 2 shows the result given by a partially decomposed alkaline solution of reductone. A special aldehyde reagent[5], which has the advantage of giving differently coloured spots, was used to locate the compounds. The paper was sprayed with a 0·5 per cent solution of thiobarbituric acid in acetic acid, and then heated for 5 min. at 80° C. The numbers placed under the electrogram refer to spots which were clearly visible in the original. The main spot (1) due to undecomposed reductone was bright yellow in colour. The main decomposition product gave rise to a reddish-brown spot (2); the mobility of this compound is slightly greater than that of ascorbic acid, from which it may be distinguished by the fact that pure ascorbic acid gives no colour with the reagent. (The tail which forms on the ascorbic acid spot during electrophoresis of the latter does react and produces a yellow colour.) Other fainter spots (3 and 4) are also in evidence. The compounds responsible for 2 and 3 have not yet been identified; 4 seems to correspond with glyceraldehyde, which was postulated by Sattler *et al.*[6] as a product of the alkaline degradation of sugar.

The above observations on the colour of the spots given by reductone and the aged solution suggest that the band observed by Landucci[7] at 535 mμ in the absorption spectrum of the reaction product of reductone and thiobarbituric acid is due, not to reductone itself, but to a degradation product.

It is hoped to describe the application of this work elsewhere. It is already clear that the reducing agent of photographic gelatin which reacts immediately with iodine is mainly sulphite. The latter is, of course, well known to be present in gelatins generally.

Thanks are due to the Directors of Ilford, Ltd., for permission to publish this communication.

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Estimation of Phenolic Substances: Use of Stabilized *p*-Aminodiethylaniline

I reported in a recent communication[1] that, in the presence of periodic acid as oxidant, ketosteroid salicyloylhydrazones couple readily with stabilized *p*-aminodiethylaniline to form intensely coloured blue-green indoanilines[2]. Further investigation has made it clear that this reaction compares favourably with existing phenol reactions in respect of sensitivity, specificity, stability and optical properties.

Estimation of salicyloylhydrazones was carried out in the following way. To 5–50 μgm. of the salicyloylhydrazone dissolved in 1 ml. ethyl acetate was added 1 ml. of 0·1 per cent solution of stabilized *p*-aminodiethylaniline (a sulphur dioxide compound of *p*-aminodiethylaniline marketed by Messrs. May and Baker as 'Genochrome'). 1 ml. of 5 per cent aqueous sodium bicarbonate was added, followed by 2 ml. of a saturated aqueous solution of potassium periodate. The reaction mixture was then shaken thoroughly to ensure intimate mixing of the two phases during the formation of the indoaniline. 3 ml. of water and powdered sodium chloride were then added, followed by the required amount of ethyl acetate. A crystal-clear intensely coloured supernatant organic phase resulted, which was decanted and read in a Spekker colorimeter against a blank determination using a suitable filter.

It was found that potassium ferricyanide was also effective as an oxidant, and the use of this technique is illustrated by the following method for the estimation of phenols. To 1–10 μgm. of phenol dissolved in 1 ml. of water was added 0·4 ml. of 0·1 per cent stabilized *p*-aminodiethylaniline, 0·5 ml. of 0·33 per cent potassium ferricyanide and 0·5 ml. of 5 per cent potassium pyroborate, and the intensity of the colour was read directly. If less than 1 μgm. of phenol is being estimated, the indoaniline should be extracted into *n*-butanol or chloroform. If necessary, the chloroform or *n*-butanol extract may be concentrated by distilling off some of the solvent, the colour remaining stable under these conditions.

As well as periodic acid and potassium ferricyanide, it was found that both silver nitrate and mercuric chloride were effective as oxidants; these findings are of potential application in histochemistry.

The reaction appears to be quite general for phenolic substances, some colour variation being obtained with different phenols.

The estimation of acid and alkaline serum phosphatases by determination of the liberated phenol as the indoaniline is under investigation. In that the colour is stable for some days and the proteins do not need to be precipitated, this method seems preferable to existing methods. A full report of this work will be presented shortly.

I am grateful to Prof. J. Patterson for his guidance and to Miss J. Hart for technical assistance.

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Destruction of Isoniazid in the Presence of Hæmin

It has been shown that hæmin strongly antagonizes the antibacterial action of isoniazid (*iso*nicotinoylhydrazine) on strains of *Mycobacterium tuberculosis* sensitive to this drug[1]. These observations have been confirmed and extended[2]. Isoniazid is destroyed in uninoculated media when hæmin is present (see ref. 3, also personal communication from G. P. Youmans). The work to be described was undertaken to find whether the destructive reaction was catalytic or not, to identify the products, and to consider some biological implications.

When isoniazid (10^{-3} *M*) and hæmin (10^{-3} *M*) were shaken with air at 20° (*p*H 7·5, phosphate or 'tris' buffer) only two substances were formed: di*iso*nicotinoylhydrazine (I) and *iso*nicotinic acid (II). Under these conditions, (I) was not formed from the reaction of isoniazid with (II), as has been claimed by Krüger-Thiemer[4], but was an intermediate in the formation of (II). These products were isolated and identified. Quantitative paper chromatography showed that after 24 hr. half the isoniazid was unchanged and the rest was converted to equal amounts of (I) and (II). Without hæmin, the reaction took the same course, but more slowly (cf. Bönicke and Reif[5]), and hence the role of hæmin was catalytic. No reaction occurred under nitrogen, even at 85°.

For following the disappearance of very low initial concentrations of isoniazid (10^{-4} *M* or less) only microbiological methods, using *Myco. tuberculosis* as test organism, were delicate enough. In the presence of hæmin (10^{-4} *M*) the concentration of isoniazid was found to fall below 10^{-7} *M*, and here too the hæmin appeared to be acting catalytically.

With a direct-vision spectroscope it was found that hæmin rapidly formed a hæmochromogen ($\lambda_{max.}$ about 560 and 525 mμ) with an excess of isoniazid, or with less isoniazid when a reducing agent (sodium hyposulphite) was present. The hæmochromogen was purple, and distinct from the orange-red hæmochromogens formed with pyridine, with nicotinic acid hydrazide and with picolinic acid hydrazide. The main band of reduced hæmin as well (580 mμ) was seen when the isoniazid/hæmin molar ratio fell below 2 to 1. Solutions of this hæmochromogen were stable only in the absence of air. Substance (I), but not (II), slowly formed a hæmochromogen. Many hæmochromogens are more efficient oxidation catalysts than hæmin[6], and it is possible that this hæmochromogen is the true catalyst.

To study antagonism of the action of isoniazid, some sets of tubes of asparagine glycerol phosphate medium[7] containing isoniazid (10^{-4} to 10^{-7} *M*) were inoculated with *Myco. tuberculosis H* 37 *Rv*. When hæmin (10^{-4} *M*) was added immediately, the bacteria grew normally; but if the addition was delayed for one day their growth was slow, and if it was delayed

for two to three days, growth did not occur at all in the lower concentrations of isoniazid. (These results seem to be at variance with those of Fisher[8], who re-initiated growth by hæmin, after long periods of bacteriostasis under apparently similar conditions.) This failure of hæmin to antagonize isoniazid may mean that in three days the drug has reached a site in the bacillus which is inaccessible to hæmin, or is at too low an E_H to be oxidized there, or simply that within three days isoniazid has effected damage of an irreversible nature in the cell.

Relevant portions of this work will be submitted respectively to the *British Journal of Experimental Pathology* and the *Biochemical Journal*. Our thanks are due to Dr. E. F. Hartree for valuable help and suggestions about the spectroscopy.

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Some Unusual Carotenoids from Two Nudibranch Slugs and a Lamprid Fish

Recently, it has been possible to examine briefly some rare carotenoids of three conspicuously pigmented animals found in the waters off southern California.

Archidoris montereyensis, the sea lemon, is a nudibranch of generally light, slightly dirty yellow colour, with small scattered brown, greyish or black skin-spots and a pair of elongated, finger-like, pointed rhinophore tentacles. Two whole specimens were finely comminuted under acetone in a Waring blendor, and the yellow pigment was transferred from the separated solvent into light petroleum by dilution with water. In the partition test with 90 per cent methanol, all the pigment remained epiphasic, that is, in the petroleum, even following treatment with alcoholic potash. Its absorption spectrum was very similar to that of β-carotene. On chromatography, using activated alumina, a minor fraction (about 5 per cent of the total) was eluted with light petroleum containing 5 per cent ether, and appeared to be β-carotene, while the major compound migrated downward when more ether (10–20 per cent) was added to the light petroleum. The absorption spectrum of this major fraction showed maxima at 475 mμ, 450 mμ and an inflexion at about 425 mμ (Fig. 1; Beckman photoelectric spectrophotometer, Model *DU*), thus differing slightly from β-carotene, from an authentic sample of which it could also be separated chromatographically. Although adsorbed more firmly on alumina than β-carotene, it adhered less strongly than cryptoxanthin (3-hydroxy-β-carotene).

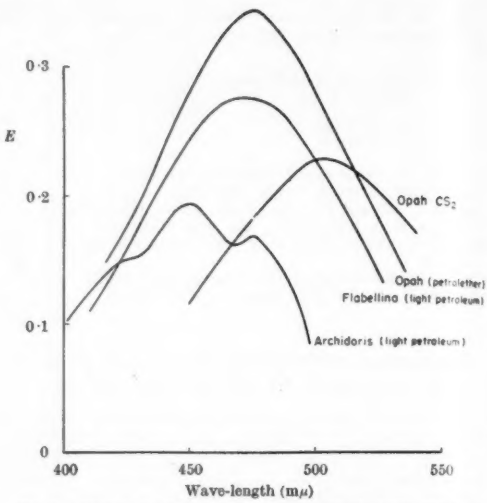

Fig. 1. Absorption spectra of the carotenoid pigments obtained from *Archidoris montereyensis*, *Flabellina iodinea* and *Lampris regius* (the opah or moonfish)

It appears rather similar to an unidentified pigment observed in human blood and milk[1] and in berries of *Lonicera japonica*[2].

The finding of only hydrocarbon-like (persistently epiphasic) carotenoids in a marine mollusc seems to be almost unique, since these animals are generally characterized by solely or predominantly hypophasic carotenoids[3]. The deep rose-pink nudibranch, *Hopkinsia rosacea*, yields no carotenes or esterified xanthophylls, but a new xanthophyll with absorption maxima at 497 mμ and 466 mμ in petroleum ether, believed by Strain[4] to be a ketone.

Flabellina iodinea, the purple sea-slug occurring commonly off La Jolla, has bright purple-violet or purple-blue body skin, orange-red rhinophores and orange-coloured cerata. Two specimens extracted in the same manner as was *Archidoris* yielded a hypophasic carotenoid showing a single, symmetrical absorption maximum at 470–475 mμ in petrol ether (Fig. 1). This type of spectrum suggests that the pigment may be an oxygenated carotenoid, possibly of ketonic nature; it is not, however, of the astaxanthin class, since it exhibited no acidogenic properties after treatment with ethanolic potash. The fact that the purple colour of *Flabellina* changes to red-orange upon treatment with alcohol suggests the presence of a carotenoid protein complex, common in many invertebrates.

Lampris regius. The opah or moonfish, a large oceanic species showing a roundish dorso-ventral profile, with compressed sides, has a brilliant red pigment in the skin, fins, lips and tongue. The specimen examined was taken on a baited hook and long line at a depth of some forty fathoms, approximately four hundred miles west of Magdalena Bay, Baja California. It and other similarly caught specimens contained a few fish and many argonaut cephalopods in the stomach.

The red pigment, recoverable from any of the tissues mentioned above, is somewhat similar to that obtained from *Flabellina*, being persistently non-acidogenic, although exhibiting a symmetrical, single-banded absorption spectrum, with a maximum at 475 mμ in petrol ether, and at 504 mμ in carbon

disulphide (Fig. 1). This is somewhat reminiscent of a neutral xanthophyll recovered by Lederer[5] from freshwater perch (*Perca fluviatilis*) in that that compound gave a single maximum at 495 mμ in petrol ether and 510 mμ in carbon disulphide.

The opah does not store the crustacean carotenoid, astaxanthin, but may obtain its carotenoid, deriving ultimately from such a source, through its heavy diet of argonauts.

We wish to acknowledge with thanks the generosity of Mr. John A. McGowan for the nudibranchs collected by him, and of Mr. Allan J. Stover and Prof. Carl L. Hubbs for the opah material and information concerning the species. Thanks are also due to the Rockefeller Foundation for financial assistance.

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Intracellular Distribution of Xanthine Oxidase in the Rat Liver

The separation of cytoplasmic particles into fractions by differential centrifugation has been extensively used for the study of the distribution of intracellular cell constituents. Some enzymes of oxidative metabolism have been shown to be localized chiefly in the fraction of the liver containing large particles (mitochondria)[1]. During the course of an investigation of the xanthine oxidase of the rat liver, we have studied the intracellular distribution of this enzyme, since there seem to be no data in the literature.

The xanthine oxidase activity was measured by the oxygen uptake in a Warburg respirometer using a pyrophosphate buffer *p*H 8·6, as previously described[2]. Xanthine dehydrogenase activity was determined in Thunberg vacuum tubes, and the reduction of the dye triphenyltetrazolium chloride measured colorimetrically as formazan[3].

Male Wistar white rats were decapitated and livers were rapidly excised, placed in cold 0·25 *M* sucrose, cut into small pieces and the connective tissue removed by forcing through a gauze. The liver pulp was weighed and homogenized in 9 volumes of ice-cold sucrose. The differential centrifugation was performed according to the procedure of Hogeboom, Schneider and Pallade[4]. All the glassware and the fractions were kept in ice during the operations. The homogenates were centrifuged at 600*g* for 10 min. The supernatant and the washings were centrifuged at 8,500*g* for the separation of the mitochondria. The last centrifugation was at 20,000*g* for 60 min. All the sediments were washed twice with ice-cold 0·25 *M* sucrose and the washings added to the supernatants. The fractions were checked by staining with Feulgen and Janus green and examined microscopically. Nitrogen was determined in the fractions as a control[5].

Table 1. Intracellular Distribution of Rat Liver Xanthine Oxidase

Fractions*	Xanthine oxidase		Xanthine dehydrogenase		Total nitrogen§
	Activity†	Percentage	Activity‡	Percentage	
Homogenate	1,077	100	1,270	100	3,295
Nuclei	0	0	0	0	480
Mitochondria	0	0	0	0	769
Submicroscopic particles (microsoma)	0	0	0	0	635
Supernatant (cell sap)	691	64·15	1,325	104·3	1,605

* Experiments carried out on four rats.
† Oxygen (c.mm.) per gm. dry weight/60 min.
‡ Formazan (μgm.) produced per gm. dry weight/30 min.
§ Nitrogen (μgm.) per 100 mgm. wet liver.

Table 1 shows the intracellular distribution of xanthine oxidase and dehydrogenase activities in the four fractions studied. The results clearly demonstrate that practically all the enzymic activity is present in the supernatant fluid corresponding to the cell sap containing the soluble proteins of the cell. Little or no activity could be detected for the nuclear, mitochondrial and microsomal fractions. The enzymatic activity of the mixture of the four fractions was 102 per cent of that of the original homogenate. It is interesting to know that uricase was found only in the mitochondria[6], in contrast to xanthine oxidase, which is absent from this fraction. The decreased percentage obtained for xanthine oxidase in the cell sap as compared with the xanthine dehydrogenase could be explained by the greater stability of the latter as shown by Richert *et al.* in their inhibition studies[7].

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Actively Acquired Tolerance to a Mouse Tumour

The 6*C3HED* lymphosarcoma[1] is an ascites tumour of mice, apparently of uniform antigenic properties, containing a near-diploid mode of chromosomes[2]. It is invariably lethal to *C3H* mice and to F_1 hybrids between the original strain and *A* or *DBA* mice. The tumour consistently regresses in mice of other strains. Since Billingham, Brent and Medawar[3] have recently demonstrated that mice can be rendered susceptible to skin homografts by the injection of embryos *in utero* with donor-strain tissues, the same method has been applied to the abrogation of resistance of a strain of Swiss mice to the 6*C3HED* tumour.

Embryos of the *ICR* (Institute for Cancer Research, Philadelphia, Pa.) strain of Swiss mice were injected *in utero* on the sixteenth to seventeenth day of

gestation with one of the following: blood of *C3H* mice, blood of F_1 generation *C3H* × *DBA* mice, or a suspension of 6*C3HED* ascites tumour cells. Trypan blue was incorporated into the inocula so that, following birth, mice which had actually been injected *in utero* could be distinguished easily by their blue coloration. Mice which received as embryos the blood of either *C3H* or F_1 (*C3H* × *DBA*) mice were implanted at the age of six to eight weeks intraperitoneally with cells of the 6*C3HED* ascites tumour. All injected mice in both groups developed ascites, which progressively increased in volume. Aliquots of ascites fluids, which contained large numbers of tumour cells, were subinoculated into groups of adult *ICR* mice. The second passage of ascites resulted in the deaths of some of the inoculated mice, and the two sublines have been maintained without difficulty in *ICR* mice as ascites tumours for twenty-seven passages up to date.

ICR mice injected in the embryonic stage directly with tumour cells (*vide supra*) developed palpable tumours, always in the subcutaneous tissue of the neck, on the tenth to twenty-fifth day after birth. These tumours were removed seven to ten days after they were first detected, and made into a suspension which was implanted intraperitoneally into adult *ICR* mice. Ascites developed in all these mice, and half the animals died ten to twelve days after implantation of the tumour. This subline has been maintained for thirty passages up to date.

The three derivative sublines of the 6*C3HED* tumour lost completely the host specificity of the original tumour. All strains of mice so far tested have been found equally susceptible to the lethal effect of the tumour, implanted either intraperitoneally or subcutaneously. The cancer cells of the derivative lines are morphologically very similar to those of the original tumour, although the cellular volumes of the latter are somewhat less. Marked differences were observed, however, in the chromosome ploidy of the tumours. The study of chromosome number distribution for the main line of 6*C3HED* tumour (grown in *C3H* mice) indicated modal values at or near diploid with very little variability[2]. Cells of the three derivative Swiss mice-adapted tumours are characterized by greater polyploidy of the chromosome number, with the hyperdiploid mode prevailing.

Infection of the tumours with viral agents revealed the most striking differences in biological characteristics between the main line and the derivative tumours. Mengo and Bunyamwera viruses[4,5] failed to grow in the tumour tissue and to exert an oncolytic effect upon the original 6*C3HED* tumour, although they killed the *C3H* host. In contrast, the same viruses multiplied in all three Swiss mouse-adapted sublines and destroyed the tumour cells.

The results of this investigation indicate that the method of enhancing susceptibility to skin homografts advanced by Billingham, Brent and Medawar[6] can be extended to the field of tumour homografts. The direct inoculation of the embryo with tumour cells, resulting in abrogation of resistance and acquisition of tolerance on the part of the recipient after birth, offers possibilities for further exploration. This work also shows that an ascites tumour transplanted to a tolerant mouse may undergo a profound change of antigenic specificity. The mechanism underlying this change may be selective. According to Billingham, Brent and Medawar (personal communication), the tolerance produced by whole blood in embryos which cannot be injected intravenously is relatively feeble; a weak residual immunity could well exert a selective action on what is essentially a population of isolated tumour cells.

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April 19.

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[2] Levan, A., and Hauschka, T. S., *J. Nat. Cancer Inst.*, **14**, 1 (1953).
[3] Billingham, R. E., Brent, L., and Medawar, P. B., *Nature*, **172**, 603 (1953).
[4] Koprowska, I., and Koprowski, H., *Cancer Res.*, **13**, 651 (1953).
[5] Koprowska, I., and Koprowski, H., *J. Nat. Cancer Inst.*, **14**, 627 (1953).
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Parasitological Significance of Bovine Grazing Behaviour

The bovine habit of not eating grass growing in the vicinity of bovine fæces has been the subject of occasional speculative writing, which has discussed the supposed value of such behaviour in protecting the animal from parasitism. A recent study of the free-living stages of the cattle lungworm[1] suggested that, in order to ingest the larvæ, the bovine host had to ingest bovine fæces. An investigation into certain aspects of grazing behaviour appeared to be warranted, and as a first step observations were made to determine whether by virtue of its apparently selective pattern of grazing the bovine did indeed ingest fewer larvæ than it would if its grazing were entirely at random.

It was found that, by following and observing grazing cattle, it was possible to see with considerable accuracy from where grass was being taken. Not only was the freshly bitten grass of a slightly different colour, but also the spot from which each mouthful had been pulled could be discerned by the displacement and compression of the grass. Young cattle grazing on a paddock known to be heavily infected with *Dictyocaulus viviparus* were followed in this manner, and samples of herbage were taken by cutting small pinches from immediately beside the bitten spots. At the same time, random samples were taken from the paddock by a standard procedure.

Comparison of the concentration of lungworm larvæ in samples taken by these two methods showed that in twenty-five cases out of twenty-six the herbage collected after the manner of the animals contained fewer larvæ than the random samples. The

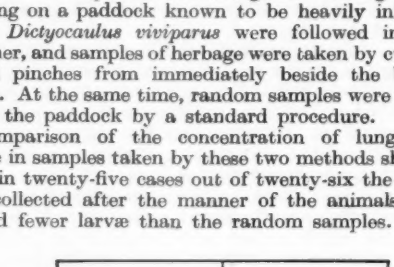

Fig. 1. Larvæ in grazing samples as a percentage of larvæ in random samples

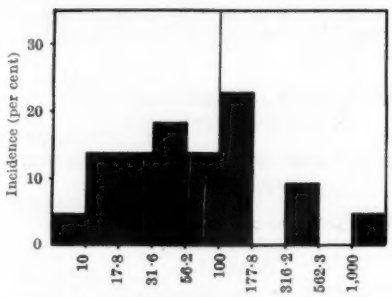

Fig. 2. Larvæ in short grass as a percentage of larvæ in random samples

frequency distribution of the larval concentration in these 'grazing samples' expressed as a percentage of the appropriate random samples is shown in Fig. 1, from which it will be seen that bovine grazing is indeed highly selective from a parasitological point of view.

Concurrently with these observations and using the same paddock, a comparison was made between the concentration of larvæ in samples taken from the areas of short grass which had evidently relatively recently been grazed and the random samples. Fig. 2 shows the frequency distribution of the larval concentration in these samples of short grass expressed as a percentage of the random samples. While there is a tendency for the short grass to contain fewer larvæ than the random samples, it is clear from a comparison of Figs. 1 and 2 that the success of the animal in avoiding infection depends on something more than its ability to distinguish between short grass and the rank tussocks of herbage growing around pats of fæces.

J. F. Michel

Veterinary Laboratory
(Ministry of Agriculture),
Weybridge.
Jan. 31.

[1] Michel, J. F., and Rose, J. H., *J. Comp. Path.*, **64**, 195 (1954).

Classification of Geckos

I have recently put forward proposals for the classification of geckos[1]. In this paper the view was advanced that the amphicœlous condition of the vertebræ characteristic of the majority of geckos is secondary, derived from the procœlous condition found in all other recent lizards. Of the three families of geckos recognized the two which conserve primitive ophthalmological characters, Eublepharidae and Sphaerodactylidae, are procœlous. I therefore supposed that primitive geckos were procœlous and that the Gekkonidae s.s., which show the most complete conversion to secretive and nocturnal habits, are secondarily amphicœlous. More or less implicit in this view was the idea that the procœlous condition was early fixed in the definitive lizard stock.

It is now becoming increasingly clear that there was in the Triassic a considerable radiation of amphicœlous definitive lizards. Some Middle Triassic forms are discussed by Kuhn-Schnyder[2], and Miss Pamela Lamplugh Robinson, of University College, London, has shown me some beautifully preserved material of an Upper Triassic lizard fauna in Britain. All these are amphicœlous; it is therefore clear that definitive lizards appeared long before the 'fixation' of the procœlous condition. Miss Lamplugh Robinson points out that the change from the amphicœlous to the procœlous condition is so trivial morphologically that there is no difficulty about supposing that it has occurred several times. I wish, therefore, to withdraw my earlier suggestion in favour of the more generally held view that the amphicœlous geckos preserve a primitive condition of the vertebral column. The paired condition of the atlas neural arch likewise appears to be a primitive character.

A visit to the British Museum (Natural History) has enabled me to extend this study. A detailed report is in preparation; some conclusions are here briefly noted.

Osteological study confirms the position of *Aeluroscalabates* in the Eublepharidae. Examination of the feet strongly suggests that this genus is derived from a pad-bearing arboreal stock. It thus seems likely that the entire group of geckos has originated from arboreal ancestors. I incline to regard *Aeluroscalabates* as the most archaic surviving genus of geckos; its occurrence in Borneo is noteworthy[3]. The Eublepharidae have procœlous vertebræ but retain the paired condition of the atlas neural arch. The Sphaerodactylidae have procœlous vertebræ and united atlas neural arch. The Gekkonidae retain amphicœlous vertebræ and the majority retain the paired condition of the atlas neural arch; in a number of scattered genera, however, the arch is united.

Better material of the Australian *Rhynchoedura ornata* makes it clear that it belongs to the Gekkoninae. Material of the New Caledonian *Eurydactylus vieillardi* shows that it belongs to the Diplodactylinae. The six Australian, three New Caledonian and two New Zealand diplodactyline genera form a well-defined tribe within the subfamily on osteological characters.

Quedenfeldtia is placed in the Diplodactylinae on osteological grounds. The following genera are allocated to the Gekkoninae on pupil-shape: *Briba*, *Ceramodactylus*, *Dravidogekko*, *Homonota* and *Perochirus*. On characters of osteology and squamation, *Ancylodactylus*, *Cnemaspis* and *Pristurus* appear to be related to *Cyrtodactylus* and are therefore placed in the Gekkoninae.

Garth Underwood

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Jan. 10.

[1] Underwood, G., *Proc. Zool. Soc. Lond.*, **124**, 469 (1954).
[2] Kuhn-Schnyder, E., *Endeavour*, **13**, 213 (1954).
[3] Darlington, P. J., *Quart. Rev. Biol.*, **23**, 1 and 105 (1948).

Scale-eating Habits of African Cichlid Fishes

In a recent communication, Marlier and Leleup[1] have described how the Tanganyikan Cichlid fishes of the genus *Plecodus* deliberately attack other fishes and bite off the scales, which are their sole or main means of subsistence. These authors mention the specialized, large, curved teeth which enable the species of *Plecodus* to feed in this way and remark on the apparent uniqueness of the habit.

Although this seems to be the only observation of fishes engaged in such a habit, a similar diet has been recorded for Nyasan Cichlids of the genus *Corematodus*. During the 1939 Fishery Survey of Lake Nyasa[2], six specimens each of *C. shiranus*

Boulenger and *C. taeniatus* Trewavas were examined and the stomachs and intestines were found to be full of minute fish scales, matching in size and structure those that densely coat the caudal fin in the Nyasan Tilapias and other Cichlid fishes. The dentition of *C. shiranus* is figured by Boulenger[3], who describes it as consisting of "extremely broad bands of innumerable minute club-shaped teeth with compressed oblique crowns". Trewavas[4] describes how the caudal fin of a *Tilapia* can be held between the upper and lower file-like tooth-bands of *Corematodus* and only pulled free at the cost of losing some scales.

During the course of work on a rocky shore of Lake Nyasa, one of us (G. F.) has recently collected five specimens of the little-known endemic Cichlid *Genyochromis mento* Trewavas. The guts of all five contained a number of relatively enormous fish scales, evidently derived from Cyprinid fishes of the genus *Labeo*. These scales were partly digested and apparently constitute the main food of the species, as in all cases they composed the bulk of the gut contents, sometimes to the exclusion of all else. In one specimen they were accompanied by a few slender fin-rays but by no other bones, and in another by a very small quantity of filamentous algae.

The dentition of *G. mento*, figured by Trewavas[5], is quite different from that of either *Corematodus* or *Plecodus*. The lower jaw is stout and prominent. Both jaws bear bands of teeth, of which all but those of the outer row are tricuspid; the outer are bicuspid. If the outer teeth of the lower jaw are inserted under the edge of a scale of *Labeo* the scale is easily removed.

Genyochromis mento is related to *Pseudotropheus*, *Petrotilapia* and *Cyathochromis*, the members of which graze on epiphytic and epilithic algae. Baerends and Baerends-van Roon[6] describe in *Tilapia natalensis* "a peculiar way of eating algae from substrates. It opens the mouth widely, presses it against the substrate and closes it while pressing". This is very similar to the account by Marlier and Leleup of the action of *Plecodus* in biting scales from its victims. One of us (P. H. G.) has noticed in a Cyprinid, *Labeo*, of Lake Victoria, behaviour that suggests a possible step by which a grazer on algae may become a scale eater. The *Labeo* was seen repeatedly to graze on the sessile rotifers growing on the flanks of a *Polypterus* kept with it in an aquarium. *Labeo* has toothless, sharp-edged jaws; but most Cichlid grazers on algae, including those related to *Genyochromis*, have bands of movable teeth. The teeth of *Genyochromis* are relatively firmly fixed. The same jaw action would shave the surface where the teeth are movable and remove scales where the teeth are fixed, especially with a prominent lower jaw. These rather scattered observations suggest how the scale-eating habit in *Genyochromis* might evolve from the grazing, with a change from movable to fixed teeth.

The three genera that have adopted the scale-eating habit are not very closely related within the family Cichlidae and have achieved the same end by dissimilar means.

Except that it seems to be related to *Perissodus*, a genus that also has a specialized dentition, the ancestry of *Plecodus* is obscure; but it does not necessarily follow that because some individuals will take a bait the species or its ancestor is predominantly voracious. Yet in this case scale-eating may be a modified predation, as it almost certainly is in *Corematodus*.

The work on *Genyochromis* is part of a study now in progress of the ecology of some littoral zone fishes in Lake Nyasa.

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Nkata Bay, Nyasaland.
P. H. Greenwood
East African Fisheries Research Organization,
Jinja, Uganda.
E. Trewavas
British Museum (Natural History),
London, S.W.7.
April 14.

[1] Marlier, G., and Leleup, N., *Nature*, **174**, 935 (1954).
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Permanent Preparations of Nematodes

While working on the micro-fauna of Whitstable, I found that mounting media containing lactic acid were unsuitable for making permanent preparations of nematodes; they cloud in this medium on keeping.

An attempt was therefore made to prepare mountants based on creosote, which is the outstanding clearing agent for these animals. Of these mountants the most successful is a solution of 'Perspex' in creosote, although solutions of methyl cellulose and ethyl cellulose in this solvent were also valuable.

The mountant is prepared by heating creosote on a water-bath and adding 'Perspex' powder until a solution of the required viscosity is obtained.

The method of mounting nematodes in this medium is as follows: extend, kill and fix in hot 70 per cent alcohol (alternatively, extend and kill by warming up in sea water; fix in formol–acetic mixture); wash in 70 per cent alcohol; drain; clear in creosote; mount in creosote/'Perspex' mountant.

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March 1.

Adaptability of Wheat Varieties to Acid Soils

It is common experience that certain varieties of wheat can tolerate a considerable degree of acidity in soils, while other varieties, although botanically similar, are very sensitive to this condition. As work in recent years has shown that the soil acidity complex can be resolved into a number of separate factors[1], it was decided to investigate the importance of two of these factors—aluminium and manganese toxicity—in relation to the acidity tolerance of wheat varieties.

Four varieties, known to show a differential response towards soil acidity, were selected for special study. These were grown in sand culture in the open, the general technique being similar to that of Hewitt[1]. The varieties were: (1) Atle, which is extremely sensitive, (2) Karn II, which is moderately sensitive, (3) Progress, which is moderately tolerant, and (4) April Red, which is comparatively immune, to soil

Table 1

Parts per million	Mn I 27	Mn II 55	Mn III 82	Mn VI 110	Mn V 137	Al I 108	Al II 162	Al III 216	Al IV 270
Atle	Slight	M. severe	Severe	Severe	Severe	Slight	V. severe	V. severe	V. severe
Karn II	Slight	Slight	M. severe	M. severe	M. severe	Severe	V. severe	V. severe	V. severe
Progress	Slight	Slight	M. severe	M. severe	M. severe	M. severe	V. severe	V. severe	V. severe
April Red	Unaffected	Unaffected	V. slight	Slight	Slight	Slight	Severe	Severe	Severe

acidity. Table 1 shows the reaction of the varieties as indicated by the severity of the symptoms on the foliage.

The yields of dry matter expressed as a percentage of control are given in Table 2.

Table 2

Treatment	Atle	Karn II	Progress	April Red
Control (Mn at 0·55 p.p.m.)	100·00	100·00	100·00	100·00
Mn at 27 p.p.m.	90·51	90·51	82·00	117·90
,, 55 ,,	56·19	85·04	82·34	114·76
,, 82 ,,	50·77	68·79	65·02	100·81
,, 110 ,,	38·48	41·30	59·52	76·74
,, 137 ,,	17·98	33·29	54·47	50·96
Al at 108 p.p.m.	39·93	21·12	19·84	42·16
,, 162 ,,	11·02	4·72	8·94	17·49
,, 216 ,,	5·96	4·15	5·62	15·87
,, 270 ,,	7·77	4·15	7·97	11·63

These results show that varieties may behave somewhat differently towards the individual factors which constitute the acidity complex of the soil—some varieties being rather tolerant of excess aluminium whereas other varieties were more tolerant of high concentrations of manganese.

It will be observed that the variety April Red, noted for its tolerance of acidity, is comparatively resistant to both manganese and aluminium toxicity. This may be correlated with its high requirement of manganese, which is indicated by the positive response obtained from applications of up to 82 p.p.m. of this element.

Further experiments with other cereals indicate that these also show a differential reaction to these factors of the soil acidity complex.

A full account of this work will appear shortly (*J. Dept. Agric., Dublin*).

M. Neenan

Soil Laboratory,
Department of Agriculture,
Johnstown Castle Agricultural College,
Wexford. March 4.

[1] Hewitt, E. J., Long Ashton Res. Sta. Ann. Rep. 1946 (1948).

Disomic Addition of Rye Chromosome II to Wheat

It has been suggested[1] that the most satisfactory way of transferring agriculturally advantageous characters to *Triticum vulgare* ($2n = 42$), bread wheat, from diploid species of related genera may be by the production of alien chromosome disomic additions or substitutions. During work concerned with the production of rye (*Secale cereale*) chromosome additions in *T. vulgare*, a 28-chromosome plant, which arose parthenogenetically in the progeny of the octoploid amphidiploid *T. vulgare* var. Holdfast × *S. cereale* var. King II, was crossed with the *T. vulgare* parent. A single F_1 plant was obtained, and this had 49 chromosomes which formed 21 bivalents and 7 univalents at meiosis, that is, it had the full *T. vulgare* complement plus the rye haploid complement of chromosomes. Our usual procedure is to make a further back-cross of such 49-chromosome plants to extract the 43-chromosome, monosomic addition, types which form the most frequent class in the aneuploid range obtained in this way. Afterwards, disomic addition types have been obtained in the progeny of selfed monosomic addition plants, and this work will be described elsewhere. However, this 49-chromosome F_1 plant was also allowed to self, and among the progeny obtained in this way was a plant with 44 chromosomes in which the two added rye chromosomes were identical. This may be recognized from the morphology of the chromosomes (Fig. 1), both of which had a sub-median centromere and a pronounced secondary constriction giving rise to a clear satellite. There is only one pair of chromosomes with this morphology in *S. cereale* (Fig. 2). The equivalence of the chromosomes is further proved by the occasional formation of 22 bivalents at meiosis. This plant had, therefore, the full complement of *T. vulgare* chromosomes plus a disomic rye chromosome.

Phenotypically the disomic plant differed from *T. vulgare* var. Holdfast in having: (1) very slight hairiness of the peduncle ('hairy neck'); (2) a narrow and tapering ear; (3) long, straight lemma points, especially in the upper part of the ear; (4) red grain.

O'Mara[2] has reported that 'hairy neck' was caused by *Secale* chromosome I, which has a subterminal centromere and a pronounced median secondary constriction; this chromosome is clearly distinct from the one under discussion, which we shall designate II, following O'Mara's precedent. The morphology and dimensions of chromosome II are identical with those of the chromosome labelled s^1 by Levan[3] in mitotic studies. However, the expression of the 'hairy neck' character in disomic addition II was less pronounced than that in I, and the two addition types also differ in other ear characters. The two chromosomes have distinctive phenotypic effects, therefore. Disomic addition II also appears very similar to descriptions of a 'hairy neck' selection, in wheat-rye derivatives, reported by Taylor[4] to have 44 chromosomes. It appears, therefore, that factors on both chromosomes I and II, at least, must be responsible for the 'hairy neck' character of *Secale*. Other evidence of the effects of chromosome II was obtained by Takagi[5], who found a rye plant in which it was trisomic to be dwarf-like, and "delicate with slender stems and leaves".

From Table 1 it may be seen that chromosome II paired at meiosis in the disomic addition plant in only 9·7 per cent of pollen mother cells (Fig. 3). Although some failure of pairing of the disomic addition chromosomes has been reported previously[1,2]

Table 1. Frequencies of Types of Pairing at M_1 in Pollen Mother Cells in Disomic Addition II (based on 62 Cells)

Pairing types	22II	21II 2I	20II 4I	19II 6I
No. of cells	6 (9·7%)	52 (83·7%)	3 (4·8%)	1 (1·8%)

Fig. 1. Photomicrograph of first anaphase of meiosis in an anther squash of a disomic addition II plant, showing *Secale* chromosome II as two longitudinally dividing univalents. × 1,350

Fig. 2. Photomicrograph of metaphase of mitosis in a root tip of *S. cereale* (after pre-treatment with α-bromonaphthalene) showing chromosome II. × 1,350

Fig. 3. Photomicrograph of first metaphase of meiosis in an anther squash of a disomic addition II plant, showing 21 bivalents and *Secale* chromosome II represented as 2 univalents. × 1,350

it does not seem to have been of this magnitude, nor was there in the present case as much asynapsis of the wheat chromosomes as has been reported previously[2]. Since in the colchicine-induced 56-chromosome amphidiploids, from which this rye chromosome was obtained, there was regular pairing to form 28 bivalents in 40 per cent of the meiotic first metaphases examined, the pairing failure in disomic addition II cannot be due to the complete homozygosity of the chromosomes of the outbreeding rye species. The implication must be that the genetic control of pairing in wheat is not fully effective for a single pair of rye chromosomes, and that these chromosomes possess no internal control which will cause regular pairing in the wheat genotypic background.

The disomic addition II plant was about as fertile as plants of the *T. vulgare* parent from which it was derived grown in similar greenhouse conditions. However, its meiotic irregularity was apparent from the chromosome number segregations in its progeny (Table 2).

It is apparent that, so far as *Secale* chromosome II is concerned, the disomic addition line is too unstable to be of value in plant breeding, and to obtain stability it may be necessary to resort to the substitution line in which a wheat chromosome pair would be replaced by the alien pair. However, we do not yet know whether all rye disomic addition plants, and analogous addition types using chromosomes of the diploid species of other genera, behave in this way.

Table 2. Chromosome Numbers of 56 Plants in the Progeny of Disomic Addition II

Chromosome number	22*	42	43	44	45
No. of plants	1	26	23	4	1

* Presumably *T. vulgare* haploid plus rye II.

We thank Dr. G. D. H. Bell, director of this Institute, for his interest and encouragement.

V. Chapman
Ralph Riley

Plant Breeding Institute,
Cambridge. April 19.

[1] O'Mara, J. G., *Genetics*, **25**, 401 (1940).
[2] O'Mara, J. G., *Cytologia*, **16**, 225 (1951).
[3] Levan, A., *Hereditas*, **28**, 177 (1942).
[4] Taylor, J. W., *J. Agric. Res.*, **43**, 603 (1934).
[5] Takagi, F., *Cytologia*, **6**, 496 (1935).

"The Sources of Eddington's Philosophy"

There is one passage in Dr. Martin Johnson's notice[1] of my recent Eddington Memorial Lecture which I fear may cause misunderstanding. Referring to my relations with Eddington, he writes: "The old instinctive antagonism is there".

In no sense was there ever any "instinctive antagonism" between Eddington and me. For the man I had the warmest regard—a feeling which I have reason to believe was reciprocated. With his outlook I had such fundamental sympathy as to have considerable confidence in my perception of what had perverted it. I could not feel that confidence concerning a view to which I was instinctively antagonistic.

Herbert Dingle

University College,
London.
May 13.

[1] *Nature*, **175**, 788 (1955).

FORTHCOMING EVENTS

Monday, June 20

ROYAL GEOGRAPHICAL SOCIETY (at 1 Kensington Gore, London, S.W.7), at 3 p.m.—Annual General Meeting.

BRITISH SOCIETY FOR THE HISTORY OF SCIENCE, PHILOSOPHY OF SCIENCE GROUP (in the Joint Staff Common Room, University College, Gower Street, London, W.C.1), at 5.30 p.m.—Mr. D. le Vay and Dr. J. F. Tait: "The General Adaptation Syndrome—the Concept and its Implication".

BRITISH PSYCHOLOGICAL SOCIETY (in the Gustave Tuck Theatre, University College, Gower Street, London, W.C.1), at 8.15 p.m.—Dr. Roger M. Barker: "Psychological Ecology of an American Town".

Wednesday, June 22

BRITISH PSYCHOLOGICAL SOCIETY, INDUSTRIAL SECTION (in Room 105, London School of Hygiene and Tropical Medicine, Keppel Street, London, W.C.1), at 1 p.m.—Mr. H. C. W. Stockbridge: "Psychology and Equipment"; Mr. D. H. Holding: "Some Relationships between Displays and Controls in Different Planes"

Wednesday, June 22—Saturday, June 25

INSTITUTE OF PHYSICS, NON-DESTRUCTIVE TESTING GROUP (at the Royal Technical College, George Street, Glasgow, C.1)—Summer Meeting.

Thursday, June 23

At 9 a.m.—Annual General Meeting.

Thursday, June 23—Friday, June 24

SOCIETY FOR THE STUDY OF FERTILITY (in the Anatomy Lecture Theatre, The Medical School, Hospitals Centre, Birmingham), at 10 a.m. daily—Conference.

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

ANALYST, Senior Scientific Officer grade (with high qualifications and appropriate experience) to conduct, under the immediate direction of the Principal Scientific Officer, routine analytical work, having particular reference to polluted surface waters, sewage and trade effluents—The Chief Pollution and Fisheries Officer, Trent River Board Laboratories, Meadow Lane, Nottingham (June 23).

LECTURER IN BACTERIOLOGY—The Secretary, The University, Aberdeen (June 23).

ASSISTANT LECTURER (with special qualifications in inorganic or physical chemistry) IN THE DEPARTMENT OF INORGANIC AND PHYSICAL CHEMISTRY—The Registrar, The University, Liverpool (June 25).

SENIOR LECTURER, LECTURER and ASSISTANT LECTURER IN THE DEPARTMENT OF PHYSICS, to work and carry out research in one or more of the following fields: nuclear physics, theoretical physics and radio-astronomy—The Registrar, The University, Manchester (June 25).

ASSISTANT IN THE DEPARTMENT OF ZOOLOGY at St. Salvator's College, St. Andrews—Joint Clerk to the University Court, College Gate, St. Andrews (June 30).

ASSISTANT IN PHYSIOLOGY—Joint Clerk to the University Court, Queen's College, Dundee (June 30).

ASSISTANT LECTURER IN AGRICULTURAL ENGINEERING AND FARM MECHANIZATION at University College, Ibadan, Nigeria—The Secretary, Inter-University Council for Higher Education Overseas, 1 Gordon Square, London, W.C.1 (June 30).

DEMONSTRATOR (with a good honours degree in psychology) IN THE DEPARTMENT OF PSYCHOLOGY—The Registrar, The University, Bristol (June 30).

MYCOLOGIST (Scientific Officer grade), to work in the Plant Pathology Department on the spread of crop diseases—The Secretary, Rothamsted Experimental Station, Harpenden, Herts (June 30).

RESEARCH ASSISTANT IN THE DEPARTMENT OF GEOLOGY—The Clerk to the Governors, Chelsea Polytechnic, Manresa Road, London, S.W.3 (June 30).

SENIOR LECTURER or LECTURER (Grade I) (with special interests in physical chemistry) IN CHEMISTRY; LECTURERS (2) (Grade II) or ASSISTANT LECTURER IN CHEMISTRY; SENIOR LECTURER or LECTURER (Grade I) IN PHYSICS, and a LECTURER (Grade I) IN ZOOLOGY, at University College, Ibadan, Nigeria—The Secretary, Inter-University Council for Higher Education Overseas, 1 Gordon Square, London, W.C.1 (June 30).

SENIOR SCIENTIFIC OFFICER (with a degree of high standard in physics or engineering, experience in measurement techniques based on optical or precision mechanical methods, and preferably with some experience in the design of optical components) IN THE DEPARTMENT OF SUPPLY, Weapons Research Establishment, Salisbury, South Australia, to undertake investigations into measurement techniques based on optical, precision mechanical and electronic methods applicable to the determination of the performance of guided missiles—The Senior Representative (AP.29), Department of Supply, Australia House, Strand, London, W.C.2 (June 30).

ASSISTANT LECTURER IN PSYCHOLOGY—The Registrar, The University, Manchester (July 1).

RESEARCH STUDENTS (with the degree of Bachelor or Master of a British University other than Manchester) IN SCIENCE—The Registrar, The University, Manchester 13 (July 1).

SCIENTIFIC OFFICER (with a first- or second-class honours degree in physics) at the National Physical Laboratory, for work on photometry and colorimetry with particular emphasis on physical methods and problems connected with the primary and secondary standards of light and the colour temperature scale—The Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S.W.1, quoting A.176/5A (July 2).

HEAD (Principal Scientific Officer grade) OF THE GRASS AND DAIRY HUSBANDRY DEPARTMENT—The Secretary, Hannah Dairy Research Institute, Kirkhill, Ayr (July 4).

LECTURER or ASSISTANT LECTURER IN THE DEPARTMENT OF ORGANIC CHEMISTRY—The Registrar, The University, Leeds 2 (July 4).

LECTURER IN AGRICULTURAL BOTANY at the University of Sydney, Australia—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (Australia, July 6).

LECTURER IN EXPERIMENTAL PHARMACOLOGY—The Secretary of University Court, The University, Glasgow (July 6).

LECTURER (preferably applicant who has worked on the dynamics of continuous media) IN THE DEPARTMENT OF MATHEMATICS—The Secretary, University College, Gower Street, London, W.C.1 (July 9).

PROFESSOR OF BOTANY at Canterbury University College, Christchurch, New Zealand—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (July 15).

LECTURER (with considerable experience in hospital biochemistry and in teaching) IN CLINICAL CHEMISTRY—The Secretary, The University, Edinburgh (July 16).

SENIOR LECTURER (veterinary surgeon with tropical experience) IN EPIZOOTIOLOGY—The Secretary, The University, Edinburgh (July 22).

LECTURER (with industrial and research experience) IN ENGINEERING—The Secretary, The University, Edinburgh (August 1).

PROFESSOR OF EXPERIMENTAL PHYSICS at the University of the Witwatersrand, Johannesburg, South Africa—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (South Africa, August 10).

PLANT PATHOLOGIST (with an honours degree of a recognized university or equivalent qualifications, together with considerable research experience in plant pathology, and preferably with a specialist knowledge of mildew diseases) at the Rubber Research Institute of Ceylon, to work mainly on Oidium and Phytophthora leaf diseases of rubber in Ceylon—The Director, Rubber Research Institute of Ceylon, Agalawatta, Ceylon, also a copy to the Secretary, London Advisory Committee for Rubber Research (Ceylon and Malaya), Imperial Institute, London, S.W.7 (August 15).

PROFESSOR OF EDUCATION at the University of Melbourne, Australia—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (Australia, August 31).

ASSISTANT, Grade A (with graduate or equivalent qualifications), to teach mathematics—The Clerk to the Governors, Luton and South Bedfordshire College for Further Education, 63/69 Guildford Street, Luton, Beds.

ASSISTANT, Grade B (with special qualifications in organic chemistry and experience in semi-micro inorganic analysis) IN THE DEPARTMENT OF CHEMISTRY, at the Technical College, Bradford—The Director of Education, Town Hall, Bradford.

ASSISTANT TECHNICAL SECRETARY (with a general science degree or equivalent qualification, and preferably with experience in metallurgical analysis, metallography or physical testing) IN THE METALLURGY DIVISION, British Iron and Steel Research Association, London—The Personnel Officer, B.I.S.R.A., 11 Park Lane, London, W.1, quoting "Assistant Technical Secretary".

CHEMIST (with at least a second-class honours degree) for fundamental research on the mechanism of dyeing, particularly on the new man-made fibres; and a CHEMIST (with at least a second-class honours degree and a leaning towards organic chemistry), for research, initially fundamental, on the chemical finishing of textiles, particularly proofings and finishes of a durable nature—Dr. F. C. Toy, Director of Research, British Cotton Industry Research Association, Shirley Institute, Didsbury, Manchester.

HEAD OF THE DEPARTMENT OF MATHEMATICS, and an ASSISTANT PROFESSOR IN THE DEPARTMENT OF MATHEMATICS—The University of New Brunswick, Fredericton, N.B., Canada.

LECTURER (with a good honours degree in electrical engineering or equivalent qualifications, and with industrial experience in electronics or telecommunications) IN ELECTRICAL ENGINEERING—The Principal, North-West Kent College of Technology, Miskin Road, Dartford, Kent.

LECTURER or ASSISTANT LECTURER (with special qualifications in organic chemistry) IN PHARMACEUTICAL CHEMISTRY—The Registrar, The University, Nottingham.

RESEARCH DEMONSTRATORS (2) IN PHYSICS, and a RESEARCH ASSISTANT IN THE DEPARTMENT OF PHYSICS, for work on ultrasonics—The Registrar, University College, Leicester.

SCIENTIFIC ASSISTANT (with a knowledge of at least two European languages and training or experience in agricultural (especially soil) science) for work in a scientific information service involving abstracting and indexing—The Director, Commonwealth Bureau of Soil Science, Rothamsted Experimental Station, Harpenden, Herts.

SCIENTIFIC OFFICER or SENIOR SCIENTIFIC OFFICER at the Merlewood Research Station, Grange-over-Sands, to initiate a small section for work on the biology of soil fungi and bacteria—The Establishment Officer, The Nature Conservancy, 19 Belgrave Square, London, S.W.1.

SCIENTISTS and SCIENTIFIC TECHNICAL OFFICERS IN THE NATIONAL COAL BOARD LABORATORIES in the Warwickshire area—The Divisional Establishment Officer, National Coal Board, Himley Hall, Dudley, Worcs.

SENIOR RESEARCH FELLOWS (with a good honours degree in chemistry (or in one case, metallurgy) of a British university, and preferably with academic or industrial research experience in inorganic or physical chemistry) IN THE DEPARTMENT OF APPLIED SCIENCE, Wolverhampton and Staffordshire Technical College—The Clerk to the Governors, Education Offices, North Street, Wolverhampton.

REPORTS and other PUBLICATIONS

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Great Britain and Ireland

Philosophical Transactions of the Royal Society of London. Series A: Mathematical and Physical Sciences. No. 934, Vol. 247 (19 April 1955): The Scattering of a Scalar Wave by a Semi-infinite Rod of Circular Cross Section. By D. S. Jones. Pp. 499–528. 9*s*. No. 935, Vol. 247 (19 April 1955): On Certain Integrals of Lipschitz-Hankel Type Involving Products of Bessel Functions. By G. Eason, B. Noble and I. N. Sneddon. Pp. 529–551. 7*s*. (London: Royal Society, 1955.) [19

Department of Scientific and Industrial Research. Report of the Road Research Board, with the Report of the Director of Road Research for the year 1954. Pp. vi+82+4 plates. (London: H.M. Stationery Office, 1955.) 4*s*. net. [254

Department of Scientific and Industrial Research. Report of the Hydraulics Research Board, with the Report of the Director of Hydraulics Research for the year 1954. Pp. vi+52+11 plates. (London: H.M. Stationery Office, 1955.) 5*s*. net. [254

Royal Institute of Chemistry. Lectures, Monographs and Reports, 1955. No. 2: Chemistry, Biochemistry and Isotopic Tracer Technique. By George Popjak. Pp. iv+59. (London: Royal Institute of Chemistry, 1955.) [254

Empire Cotton Growing Corporation. Progress Reports from Experiment Stations, Season 1953–54. Northern Nigeria. Pp. 21. (London: Empire Cotton Growing Corporation, 1955.) 9*d*. [254

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Proceedings of the Thirtieth International Congress of Americanists, held at Cambridge, 18–23 August 1952. Pp. xxx + 250 (24 plates). (London: Royal Anthropological Institute.) [254

Local Accessibility: the Hinterlands of Towns and Other Centres as Determined by an Analysis of Bus Services. Compiled by the Ministry of Housing and Local Government from information supplied by the bus operators and the Ministry of Transport and Civil Aviation. Sheet 1: Scotland and N. England. Sheet 2: The Remainder of England and Wales. (Chessington, Surrey: Director General of the Ordnance Survey, 1955.) 5*s*. per sheet. [254

Stammering: Its Cause and Cure. (A supplement to "Stammer is Not Nerves".) By H. V. Hemery. Pp. iv+17. (London: School for Functional Speech Disability, 1955.) [254

Ministry of Agriculture and Fisheries. Bulletin No. 161: British Poisonous Plants. Pp. vi+116+9 plates. (London: H.M. Stationery Office, 1954.) 6*s*. 6*d*. [254

The Control of Pests and Diseases of Farm and Market Garden Crops. Pp. 16. (Wheathampstead: The Murphy Chemical Company, Ltd., 1955.) [284

North Staffordshire Field Club. Transactions and Annual Report, 1953–54. Vol. 88. Edited by H. V. Thompson. Pp. 127+4 plates +B75–B90. (Stoke-on-Trent: North Staffordshire Field Club, 1954.) 10*s*. 6*d*. [284

Other Countries

Institut Royal Météorologique de Belgique. Publications, Série B. No. 13: Observations de la radiation Solaire durant l'éclipse de soleil du 30 juin 1954. Par R. Dogniaux. Pp. 11. No. 14: Les périodes de grands froids en Belgique (1901–1954). Par Dr. A. Vandenplas. Pp. 30. No. 15: Sur les transformations adiabatiques et isobariques dans l'atmosphère. Par L. Dufour. Pp. 10. Contributions. No. 16: Les aspects météorologique et climatologique des Pollutions Atmosphériques. Par L. Poncelet. Pp. 15. No. 17: L'aéronomie et sa nomenclature. Par Dr. M. Nicolet. Pp. 6. No. 18: Étude du climat de la radiation en Belgique. Par R. Dogniaux. Pp. 54. No. 19: Sur l'organisation de la météorologie agricole en Belgique. Par Dr. A. Vandenplas. Pp. 13. (Uccle-Bruxelles: Institut Royal Météorologique de Belgique, 1954 and 1955.) [254

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United Nations. Demographic Yearbook, 1954. (Sixth issue.) Pp. 729. (New York: United Nations; London: H.M. Stationery Office, 1954.) Cloth: 7.50 dollars; 55*s*. Paper: 6 dollars; 45*s*. [254

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Indian Forest Bulletin No. 167 (New Series): On Measurement of Toughness on Timber—Some Preliminary Investigations. By Dr. Franz Kollmann and A. C. Sekhar. Pp. ii+40. (Delhi: Manager of Publications, 1954.) 3 rupees; 14 annas. [25

Forest Research Institute, Dehra Dun. Indian Forest Leaflet No. 138: (Wood Seasoning)—Indian Timbers for Slate Frames. By M. A. Rehman, Jai Kishen and M. L. Mehra. Pp. 1+5. (Delhi: Manager of Publications, 1954.) 6 annas. [25

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Catalogue No. X160/U: The Minus Seventy Thermostat Bath. Pp. 3. (Croydon: Townson and Mercer, Ltd., 1955.)

Firmasil Borosilicate Glassware. Pp. 12. (Barnsley: Wood Bros. Glass Co., Ltd., 1955.)

"Oil Free" Compressors and Vacuum Pumps. Pp. 12. (Parkstone: Northey Rotary Compressors, Ltd., 1955.)

A. Gallenkamp and Co., Ltd. Publication No. 560: A New Fraction Collector for Column Chromatography. Pp. 2. Publication No. 561: Super-Shaker. Pp. 2. Publication 562: Mettler Analytical Balances. Pp. 2. (London: A. Gallenkamp and Co., Ltd., 1954.)

Voss Instruments. Pp. 6. (Maldon, Essex: Voss Instruments, Ltd., 1955.)

Hilger and Watts, Ltd. Publication CH 384: Hilger Metal Ratio Analyser. Pp. 4+1 plate. (London: Hilger and Watts, Ltd., 1954.)

Sunvic Controls, Ltd. Data Sheet 13: Pulse Height Analyser. Pp. 4. (London: Sunvic Controls, Ltd., 1955.)

Fielden Electronics, Ltd. Level Control—Tektor Type J. (The Application of Electronic Capacity Relays to Industrial Level Indication.) Pp. iv+28. (Wythenshawe: Fielden Electronics, Ltd., 1955.)

Eastman Organic Chemicals—Stock Items. Pp. 1+60. (Kirkby, Liverpool: Kodak Limited, 1955.)

Hopkin and Williams Chemical Catalogue. Supplement No. 2: Pp. 4. Supplement No. 3: Pp. 4. Supplement No. 4: Pp. 6. Supplement No. 5: Pp. 8. (Chadwell Heath: Hopkin and Williams, Ltd., 1954 and 1955.)

Petroleum Films Bureau. A list of 35mm and 16mm Documentary and Instructional Films. Pp. 43. (London: Petroleum Films Bureau, 1955.)

United States Information Service. The American Library. Recent additions. Pp. 34. (London: U.S. Information Service, 1954.)

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